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NEW YORK, OCTOBER, 1893.

ANNOUNCEMENT.

WITH this number of the AMERICAN ENGINEER AND RAILROAD JOURNAL we will send to each of its subscribers a copy of the first issue of "AERONAUTICS," a new publication which will hereafter be issued monthly by the publisher of the AMERICAN ENGINEER. The *raison d'être* of this new periodical is explained in the "announcement" on its second page.

Hereafter all articles pertaining to the subject of aeronautics will appear in the paper with that name, excepting those on "Progress in Flying Machines," by Mr. Chanute, which will be completed in an early number of the AMERICAN ENGINEER, and will then be issued in book form.

The 12 numbers of AERONAUTICS, referred to in its announcement, will be furnished to subscribers to the AMERICAN ENGINEER in this country for 50 cents, and to all other persons in this country for $1. Twenty cents more will be charged to foreign subscribers. A blank order for AERONAUTICS will be found enclosed with this paper, which may be filled up, and forwarded, either with or without a remittance, to M. N. Forney, 47 Cedar Street, New York.

EDITORIAL NOTES.

IN April last we began the publication of the list of accidents happening to locomotive engineers and firemen throughout the country, and for each month it is truly sickening and appalling. We have, therefore, now published these accidents for seven months, and in that time nine men have been more or less severely injured by being struck by stationary objects placed too near the tracks. Certainly this is a class that can be truly characterized as an *avoidable* accident. Every company has a rule in which it is forbidden to locate any obstruction within a shorter distance than one regularly specified. This is ordinarily put at 5 ft., though we believe it to be too close. For when a man is leaning well out of the window to watch the side rods his head is apt to come pretty close to the 5-ft. limit from the rail; but when signal posts or the temporary work used in the construction of bridges or buildings is allowed to stand so near the track as to strike an engineman while in the discharge of his duties, the some one who is responsible for allowing such a state of affairs to exist should be held strictly and criminally responsible. In our preface to our monthly publication of these accidents, we say that it is done with a hope that it will "indicate some of the causes of accidents of this kind, and the causes or cures for any kind of accidents which occur." Surely the cure for this kind is easily discovered and just as easily applied.

AFTER the struggle to obtain an armor-piercing shot and a shot-resisting armor, the latest device for naval warfare is an invisible torpedo-boat—not a boat that follows the course of Captain Nemo's craft, but a vessel that floats upon the surface and protects herself by generating a cloud of smoke, so that her actual location is concealed from the enemy. Experiments have been made with this end in view for some time, but it is not until recently that anything approaching success has been achieved. Recent work, however, at Brest would seem to indicate that the Oriolle process promises to be very successful, and if it is, an entirely new element will be introduced into naval warfare.

THE reports in the foreign technical press show that for the next year there will be what might be called a renewed activity in naval construction. France will probably authorize the building of two battleships, and the English plans are arranged for two battleships and two cruisers The work on the United States Navy also continues to be pushed, though it is not probable that there will be a launching of another large vessel before some time during the coming summer. Germany and Italy, however, seem to be doing less than England or France. Work is also progressing rapidly at the Cramp's shipyard on the new vessels for the American Line, which will form a nucleus for the new auxiliary navy which we all hope to see thrive and prosper.

LAST month saw the reopening of the meetings of several of the railroad clubs which have come to be a feature in so many parts of the country. Their growth and the large attendance at the majority of the meetings show that railroad men appreciate the opportunities which they offer, and are ready to take advantage of them. An objection has, however, been raised to some of them, that the meetings are held during the day rather than in the evening. It certainly seems as though the evening was the proper time for such gatherings, in that the local members are not taken away from their duties, while visitors or out-of-town members have the day available for travelling or visiting shops and an occupation for the evening, when time is apt to hang heavily upon their hands if there is no other employment available than that offered by the reading-room of a hotel.

COMPLAINT OF INSUFFICIENT TRAINS ON THE NEW YORK ELEVATED RAILROADS.

THE daily papers in New York now have frequent complaints, both from the editors and correspondents, of the insufficient accommodations furnished by the Elevated Railroads for the passengers who want to be carried. The law makes it the duty of the Board of Railroad Commissioners to "keep informed as to the manner in which the railroads of the State are operated for the accommodation of the public," and if "any addition to the rolling stock or in the mode of operating the road or conducting its business is reasonable and expedi-

ent, in order to promote the security, convenience, and accommodation of the public, the Board shall give notice and information in writing to the corporation of the improvements and changes which they deem proper. . . . It shall be the duty of the corporation, person, or persons owning or operating the railroad to comply with such decisions and recommendations of the Board as are just and reasonable. If it fails to do so the Board shall present the facts in the case to the Attorney-General for his consideration and action, and shall also report them in its annual or in a special report to the Legislature."

It would be interesting to know first whether the Board "keeps informed" as to the manner in which the Elevated Roads are operated and accommodate the public, and if not, why not? and if it is informed whether, in the judgment of the Board, the "accommodations" afforded between the hours of 7 and 10 A.M. and 5 and 6.30 P.M. are "reasonable." If they are "informed" and do think they are "reasonable," then nothing but a surgical operation will probably enlighten them. If, on the other hand, the Board is "informed" and does not think the accommodations are "reasonable," why do they not do their duty by "giving notice and information in writing to the corporation," as the law requires them to do, or present "the facts in the case to the Attorney-General, or report them to the Legislature?"

The General Manager of the road is reported in the *Evening Post* of September 9 to have said that no more trains could be run morning and evening with safety than are run now and have been run during the summer. What do the Railroad Commissioners think about this? The General Manager admits that some trains have been laid off during the summer. Is it not a curious fact that it is safe to run more trains at some seasons of the year than at others?

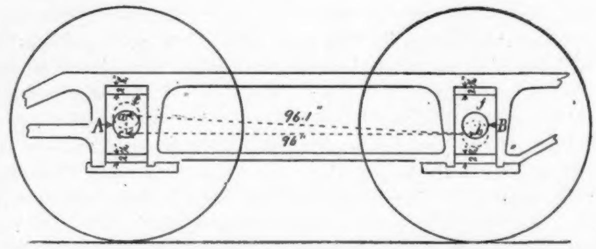
Is it not true that more trains are run on the Third Avenue line than on Sixth Avenue? Why is it safe to run that number on the east side of the city and not on the west side? All these are questions which it is the duty of the Railroad Commissioners to have answered. It is for such duties as these that the Commission has been created. If they do not perform them it might be advisable to abolish the Commission altogether. That would cost less, and the public would then probably be served just as well as it now is, although it is the duty of the Commission to know whether the service of the railroad companies is reasonable.

THE ACTION OF DRIVING-BOXES AND COUPLING-RODS.

It is the general impression among English locomotive superintendents and, to some extent, among American master mechanics, that what are called "single" passenger locomotives—that is, locomotives with only a single pair of driving-wheels—run much more freely and are capable of higher speed than engines with two pairs of coupled wheels. It is not certain that this impression is based on conclusive evidence, and it may be that, like many other general impressions, if it were subjected to rigid investigation, it would be found that to a greater or lesser degree it is erroneous. Experiments to show just how much truth and how much error there is in the impression might throw much needed light on the subject. The purpose of this article is to speculate about it, and in this way to stimulate, if possible, the interest and curiosity of some locomotive superintendents or master mechanics to make an experimental investigation of the subject.

The only cause to which the freer running of single engines has ever been assigned, so far as we know, is to the increased friction due to the effect of the coupling-rods. The pressure on the pistons in a single engine is, of course, transmitted to the crank-pins, and thence to the wheels. In a single engine the pressure on the main crank-pin journal is the same as it would be on a coupled engine, assuming that the size of the cylinders and the pressure in them are alike. In a four-coupled engine, however, one-half of the force exerted on the crank-pin of the main driving-wheels is transmitted to the leading or trailing wheels by the coupling-rods. The pressure of each end of these rods on the crank-pins, to which they are connected, is one-half of that of the main connecting-rods on the crank-pins, so that the coupling of four wheels doubles the crank-pin friction. Besides this, if there is any difference in the diameters of the front and back wheels, it will cause increased friction if they are coupled. If the tires are considerably worn, one pair may occupy a central or normal position on the rails, so that their smallest diameter is in contact, whereas the flanges of the other pair may be crowded on one side toward the rail and on the other side away from it, so that the diameter of each of the wheels at the points in contact with the rail will be greater than it is at the point where the tire is worn most. If the wheels were not coupled, this difference in diameters would have little or no effect; but if they are coupled, one pair must slip during each revolution an amount equal to the difference in the circumferences.

Besides this, an engine with coupled wheels usually has less flexibility of wheel-base than single engines have. Consequently the flange friction, especially on curves, of coupled engines must be greater than it is with single engines. The friction from all these causes must also increase with the number of wheels which are coupled—that is, it is greater on six or eight-coupled engines than it is on those with four wheels connected. The relative increase can probably only be determined by experiment.



But there is another cause, which is perhaps the most potent in increasing the friction of coupled wheels. This is the varying distance between the centers of the driving-wheels. If the practice were not so common, it would seem almost incredible that the most experienced, skillful, and ingenious engineers of the present day would adopt as their standard method of construction one which involved the use of two or more approximately parallel shafts from 6 to 9 in. in diameter, held in bearings connected together with frames of equivalent strength, in such a way that the centers of the shafts may constantly vary in their distance apart, and that these shafts are then connected together with cranks and pins and rods at each end—the cranks at the opposite ends of the shafts being at right angles to each other—and all made enormously strong to correspond with the strength of the bearings, the frames, and the shafts. Notwithstanding the incredibility of this, it is the universal practice in the construction of locomotives with coupled wheels all over the world. The accompanying diagram may, perhaps, make this clearer to some of our readers. The axle A of one pair of wheels is carried in a journal-box e, which can move vertically in the jaws about $4\frac{1}{2}$ in.—that is, $2\frac{1}{4}$ upward and the same distance downward, as indicated by the dimensions above and below the box. The same thing is true of the box f of the axle B. Supposing, now, that the axle A has moved upward the full distance permitted by the space above the box and below the frame, or $2\frac{1}{4}$ in., so that the axle is in the position indicated by the

dotted circle at a, and that the axle B has moved downward as far as the box f and the space below it will permit, or into the position shown by the dotted circle b. Evidently the distance from the center a to center b of the axles will then be greater than the distance $c\ d$, which indicates that between the centers of the two axles when the boxes are central in the jaws. By the rule that the square of the hypothenuse is equal to the sum of the squares of the other two sides, it will be found that if the axles are spread 8 ft., that the distance apart of their centers indicated by $a\ b$, when the one has moved upward and the other downward to its extreme limit, is a little more than a tenth of an inch greater than it is when the two boxes are central in the jaws, and the axles are in the position shown by the full circles A and B. It will be said or thought, doubtless, that the one box is never at the top of the jaw when the other is at the bottom, which suggests the question, How much do driving-boxes move in the jaws while an engine is running? We never knew or heard of any one having made the experiment to determine just how much this movement is. Most master mechanics and locomotive engineers have vague notions, which are deduced from casual observations of the wear of the grease and dirt from the wedges, but we have never been able to find any one who had done even this with care. We seem to be in almost absolute ignorance of the amount of actual movement of driving-boxes when an engine is running. No doubt their movement depends upon the condition of the track, speed, etc., and it might be expected that in running over a frog or crossing or bad joint that the movement would be much greater than it is on a smooth part of a line. It would be a very simple matter to attach an index-rod to one of the back driving-boxes in the cab of an ordinary American engine, and from it observe how much movement the box has. If there were a self-registering apparatus connected with the rod, it would add somewhat to the value of the experiment and greatly to its interest. Having determined how much this movement is, it would be an interesting and probably an instructive experiment to jack up an engine so that its wheels are clear of the rails, and wedge one of the boxes up and the other one down in the extreme positions which it has been found that they assume in actual running. Then kindle a light fire in the fire-box, and open the throttle, and observe how much steam pressure is required to turn the wheels. It may be that it would be very little, and, on the other hand, it seems quite possible that it would be much greater than is ordinarily suspected. We are all agnostics on this subject—that is, we know very little about it. The general impression that single engines run much more freely than coupled engines would seem to indicate that friction is greatly increased by coupling, and it may be that much of it is due to the varying distances between the centers of the driving-axles. If the upward and downward movement is only one-half the amount of play between the boxes and frames, making a total difference in the height of the two boxes of 2¼ in., then the difference in the distance between the centers of the axles when the one box is up and the other is down would be nearly one-thirty-second of an inch; not much, it is true, and yet a very considerable force would be required to stretch an ordinary coupling-rod that amount.

It may be said that ordinarily there is that much play in the bearings of coupling-rods. This may and may not be the case. When rods are newly and accurately fitted they have not that much play, whereas after running some time they may have more.

But even assuming that they have that much play, in order that the cranks may work freely, it is essential that the maximum and minimum length of the rod may coincide with the least and the greatest distance apart of the axles. If these lengths and distances do not coincide, the rods will bind and cause undue pressure and strain on all the parts. Like the little girl in Dickens's novel, who had to "make believe a great deal" in drinking lemon peel and water instead of wine, so it is necessary to make believe a great deal in thinking that there is a coincidence in the maximum length of the rods and the distances apart of the axles.

There is, in the first place, the inaccuracies in workmanship in boring the wheels for the crank-pins. Quartering machines are not endowed with infallibility, and in slight degrees of mendacity two-foot rules and gravestones emulate each other. Then there is the other fact, that in many kinds of engines the heat of the boiler has a very considerable effect on the frames, and expands them, which increases the distance apart of the axles. Allowance is not always made for this. At any rate, it is often greatly a matter of chance whether the length of the coupling-rods will coincide with the distance apart of the axles when the frames are heated or when they are cold.

Besides these chances of inaccuracy, there is the fact that the wedges, especially when double ones are used, are effective means by which careless or ignorant men may increase or diminish the distance between the axles.

The fact, too, that many more coupling-rods are broken than main connecting-rods indicates strongly that the former are subjected to much more strain than the latter.

It is, of course, impossible now to know, with any certainty, how great the defects in the coupling of engines are; but the considerations which have been brought forward indicate that the whole subject is one of those which has been allowed to drift along without receiving much intelligent attention. If this is the case, it may be that a thorough investigation, and the introduction of methods which would insure greater perfection of working parts and would correct the inaccuracies which are now permitted, and possibly the introduction of new methods of construction, might work a reform of very great importance in locomotive engineering.

It seems in the highest degree probable that coupling-rods often impose tremendous strains on crank-pins, axles, frames, and their connected parts, with a corresponding increase in friction and liability to breakage and accident. The subject seems to be worthy of thorough and intelligent investigation.

TRADE CATALOGUES.

The Brake Pressure Regulator Company, of Chicago, Ill., have issued a circular, 6 × 9½ in., 16 pp., in which their apparatus is illustrated and described. The engravings are outline process cuts, which show the construction and the details of the apparatus very clearly.

The Browne & Sharpe Manufacturing Company, of Providence, R. I., have issued a descriptive pamphlet, 5¾ × 9 in., and about 16 pp., giving information about their exhibit in Chicago. It also contains a considerable amount of collateral information about the business and the establishment of this company.

The Delamater Iron Works, of New York, have sent us two descriptive pamphlets, one referring to the Delamater-Ericsson hot air pumping engine and the Delamater-Rider hot-air pumping engine To persons interested in this subject, we think these pamphlets contain information of much value, and many whose relations are only with steam-engines will be surprised to find the extent of the various uses to which hot-air engines can and have been applied.

L. Schutte & Company, of Philadelphia, send us a small descriptive pamphlet, 4 × 6¼ in., 41 pp., which is intended to describe the appliances which they have on exhibition in Chicago. These include injectors, exhaust steam induction condensers, universal steam jet siphons; eductor or cellar drainer, furnace blower, and various kinds of steam jet appa-

ratus for moving air, gas, and vapors; air compressors and exhausters, hydraulic elevators, and valves and test pumps.

The Riehle Brothers Testing Machine Company, of Philadelphia, have sent us their catalogue No. 3. This is a large volume 9½ × 12 in., containing 56 pp. of engravings and reading matter. The special classes of products described are their standard patent testing machine, molding and countersinking machines, patent ball-bearing screw jacks, pig mill trucks and turn-tables, power, hay, and straw rope twisters, hydraulic pumps and braced railroad and warehouse trucks. The volume is very elaborately illustrated with illustrations of all these various classes of machinery, and of many special details which are furnished. The same firm also send us a reduced copy of the same catalogue, which is somewhat less than half the linear scale of the other, and is thus very convenient for being carried in the pocket.

The Bloomsburg Car Company, of Bloomsburg, Pa., have issued what they call their catalogue No. 1, which is 6¾ × 9¾ in., and contains 34 pp. This company are manufacturers of freight, mine, dump, ore, and miscellaneous cars, all of which are illustrated in the volume before us. They also illustrate views of car-wheels, lumber trucks, hand cars, and self-oiling wheels. The volume is completed by a woodcut of Suber's roller bearing, which, it is said, needs no oil, and can be run for months without any perceptible wear. The gain in friction is also said to be at least 30 per cent., and persons interested in this improvement are requested to write for further information. We should rather pin our faith to the cars which this company build than to their roller bearings, which are revived so often and so universally fail.

The Cincinnati Corrugating Company send us a pamphlet, 4¾ × 9¾ in., 8 pp., on the life of the iron roof, or how long it will last. It gives a considerable amount of interesting information concerning the roofs which this company manufactures. They also send us their illustrated catalogue, which is 6 × 8¾ in, 48 pp. This is illustrated with various diagrams and views showing the method of manufacturing their corrugating sheet metal roofs, of which this company make a specialty. Various details of manufacturing are shown, and much interesting and valuable information is given for those who contemplate using roofing of this or any other kind. It also gives information concerning metal sheathing, corrugating iron shutters, steel roofing, iron weather boring conductors, pipes, etc., all of which is well worthy of the attention of those who need or intend to have a roof over their heads.

The C. W. Hunt Company, of 45 Broadway, New York, send us several new publications, one their No. 9,306, which is a bound book, 7 × 10 in., and contains 108 pp. It describes at very considerable length the various kinds of coal-handling machinery which are manufactured by this firm, and is illustrated with excellent half-tone and wood engravings. It contains so much detail that it would occupy more time and space than we can now devote to it to describe the classes of machinery manufactured by the company. We expect to return to this subject again, however, and, in the mean while, recommend those who need automatic railways, coal elevators, steam shovels, cable railways, hoisting engines, coal tubs, wheelbarrows, coal screens or rope blocks, which are the specialties of the C. W. Hunt Company, to write and get a copy of their catalogue. They have also forwarded to us their list No. 9,305, which has the same size page as the other, and contains 50 pages, and is a brief list of the machinery which the company manufactures. A small pamphlet has also been sent to us which gives some data about their exhibit in Chicago, which will be interesting to those who visit the great show.

The Niles Tool Works, manufacturers of high-grade machine tools, labor-saving machinery. Hamilton, O.

The new catalogue of this company is 4½ × 6 in., 96 pp., and is a very convenient size and form. It is illustrated by wood-cuts giving a view of their works, a 48-in. engine lathe, a 60 in. heavy forge lathe, a No. 2 screw machine, a double axle lathe, a wheel press, a car-wheel boring machine, a cylinder-boring machine, three different sizes of boring and turning mills, 60 in. planing machine, a plate planing machine, an 18 in. shaping machine, an 18-in. slotting machine, a horizontal boring and drilling machine, a vertical drill press, a radial drilling machine, and a set of bending rolls. These engravings are printed on a rather yellowish buff tint, which is a questionable improvement to their appearance. Some of the engravings, too, have hardly had full justice done to them in the printing, although most of them are very good examples of the wood-engraver's art.

The descriptive matter is given in English, French, German, and Spanish, and the book is apparently intended for use at the World's Fair, although it is not said so. Its convenience is a great recommendation, and the general execution—engraving, paper, press-work—is excellent.

The Link-Belt Companies' engineers, founders, and machinists send us a very neatly printed and illustrated catalogue of the appliances which they manufacture. These include the Ewart detachable link belting, dodge chains, etc.; elevators and conveyers are especially designed for transporting of materials in bulk, or in barrels, bales or in boxes. The first engraving is a very good half-tone cut of the works of the company in Chicago. The next is of their establishment in Nicetown, near Philadelphia, which is followed by another one of their establishment in Indianapolis. There is then given a view of a locomotive coaling station at New Buffalo, Mich., and another in the yards of the Philadelphia & Reading Railroad at Philadelphia. Engravings are also given showing a section of an inclined conveyer for carrying lumber, anthracite coal at a coaling station of the Philadelphia & Reading Railroad. There are also views of a coaling station at Communipaw, N. J., at Wilmington, Del., at Weehawken, N. J. Several views which show an arrangement for conveying barrels are also interesting. There are other illustrations of freight conveyers, horizontal box conveyers, carriers, ice elevators, coal storage plant, a coal rolling pocket, and screen rope drivers and elevator heads, a 225-H. P. main rope power transmission, and interior views of a dynamo-room of the Virginia Hotel in Chicago, and also in the Chamber of Commerce Building—all of which are very interesting and will give the reader an idea of the extent to which this class of machinery is now used.

The Edward P. Allis Company, Reliance Works, Milwaukee, Wis. This company has sent us a new descriptive circular 9 × 12 in., 80 pp. In the introduction it is said, "The following pages are not designed either as a catalogue of machinery or as an elaborate description of our plant, but it is hoped that they will give a fair idea of the magnitude of the establishment and the high character of its productions." A variety of data is then given showing the extent of the works, the amount of manufactured products per year, etc. It is also said that the position of this establishment in its special lines is evidenced by the fact of building the largest stationary steam plant in the world; the largest pumping engine; of first introducing into the United States the triple-expansion and quadruple stationary engines and triple expansion pumping engine; by building the largest flour-mill in the world, and introducing the roller process of flour making in American mills; and building the first practical band saw-mill.

The book is printed on coated paper, and is elaborately illustrated with half tone engravings, the first one showing a view of the works with a portrait of Edward P. Allis, the founder of them. The next shows an interior view of the general offices; another one part of the drawing-room. These are followed by interior views of the foundry, machine shop, the office, the roller mill shop, and the millwright shop. Views are also given of a group of mills and elevators at Superior, Wis., which have been equipped with the machinery made by this company, and also of another mill at Mariner's Harbor, N. Y., several at Minneapolis, Minn., and one at Estill Springs, Tenn., and another in Kansas City. The first portion of the descriptive part relates to the saw-mill work which the company are doing. A partial view of the interior of the saw-mill shop is given, and an engraving of the new Allis band saw-mill, and also a view of the John R. Davis Lumber Company's mill in Wisconsin. These are followed by views of other mills which have been equipped by the Allis Company. The next portion of the catalogue relates to their stationary engine department, and is illustrated by interior views of the erecting shop; of a large Reynolds Corliss engine, and of a similar combined engine and hoisting engine; a vertical blowing engine; a triple-expansion, vertical pumping engine; a Reynolds-Corliss air compressor, and Reynolds rolling mill engine, which completes the book. The views are all excellent, and give a good idea of the scope of the manufactures of this company.

Illustrated Catalogue of Metal Working Machines, Tools, also Steam Hammers, Hydraulic Machinery, etc., manufactured by Bement, Miles & Co., Engineers and Machinists, Philadelphia, U. S. A.

In noticing the catalogue of wood-working machinery issued by J. A. Fay & Co. a few months ago, we thought that the need of superlatives in this branch of literary criticism had reached its limit. The volume before us makes it necessary to refer to our book of synonyms, and hunt up a new lot of adjectives to do it justice.

The size of the book is 12 × 9 in., and contains 358 pages. It is divided into six parts or sections on 1. Lathes; 2 Planing, Shaping, and Slotting Machines; 3. Milling Machines, Upright, Radial, Horizontal and other Drilling Machines, Upright Boring and Turning Machines; 4. Nut Tapping, Plate Bending, Punching, and Shearing Machines; 5. Hydraulic Machinery, including Steam and Hydraulic Riveters; and 6. Steam Hammers for Iron and Steel, and Steam Drop Hammers.

All the illustrations in the book are wood-cuts of the very best kind, made by Markley and J. S. C. Heiss, of Philadelphia, and Chauncey Wright, of New York. All the engravings have a whole page devoted to them. One of them, of a gun lathe, is a double-page inset. The whole of the book is printed on the best quality of coated paper, the press-work and typography being of the very best, and the latter in excellent taste, which is true of everything in the book. There is not the slightest sign of a kind of tropical exuberance which so often mars trade catalogues. Everything, even the descriptions and commendation of the tools and machines made by the firm, is temperate, which gives a tone of veracity to the whole volume.

The first illustrations are external views of the Callowhill and Twenty-fourth Street works of this firm. These are followed by some introductory remarks giving a very brief history of the establishment. After this three very excellent engravings showing the interior of their new shop on Callowhill Street. A good index—often lacking in publications of this kind—is then given, and the opening chapter on Lathes begins. This is illustrated with 25 engravings of different kinds of lathes which have from 21 in. to 125 in. swing.

The second section has 31 illustrations of Planing, Shaping, and Slotting Machines. These vary in size from machines which will plane objects 17 × 17 × 45 in. long to 122 × 122 × any required length. Another machine is described which will plane 146 × 146 in.

In the third section 51 engravings are given of different kinds of Milling, Drilling, and Boring Machines. The largest of these is a boring mill, which will swing an object 25 ft. 6 in. in diameter and 10 ft. 2 in. high, and was illustrated in our April number of this year.

Twenty-six engravings of Tapping, Bending, Punching, and Shearing Machines are given in the fourth section. The part relating to Hydraulic Machinery, Steam and Hydraulic Riveters, contains 15 engravings, which are followed by 15 more illustrations of steam hammers—in all 168 engravings. It can be said of these that there is not a poor one among them, and most of them are of superlative excellence.

As an example of the style of the descriptive matter, the following "General Remarks" on Steam Hammers may be quoted: "In designating or describing a steam hammer, it is rated by the falling weight of the piston, ram, and ram die; thus a 1,000-lb. hammer means one whose piston, ram, and die together weigh 1,000 lbs. This takes no account of the top steam used, which enormously multiplies the force of the blow, nor of the force acquired by gravity in the descent of the falling parts. The rating of a hammer, by the weight of the connected falling parts, is simple and easily understood, while any statement as to the force of the blow is difficult of expression and has no practical value. In general design and arrangement, even to the smallest details, our hammer is as simple as it can be made, and the whole construction is illustrative of a complete adaptation to its purpose. The valve-gear, arranged with the least possible number of moving pieces, takes up its own lost motion by gravity, hence it will control a hammer with great uniformity for a much longer time than would otherwise be possible. Having no connection with the ram, it escapes all concussion. It is so designed as to produce, automatically or by hand, every variation in the length, position, and force of the blow by a single lever with no extra gear. The patented adjustable guides, for taking up the wear of the ram, are an important addition, the value of which has been well demonstrated by the fact that nearly all our hammers are now provided with them. Anvils are usually made with a removable cap of iron or steel, to admit of repair or replacement without the necessity of removing the whole anvil."

GENERAL MARINE NOTES.

Trial Trip of the "Columbia."—In an unofficial trial trip of the *Columbia* made on September 12, she attained a speed of 23.3 knots, thus excelling the performance of the cruiser *New York*. The trial was made off Cape Henlopen. A heavy sea was running and the water was 14 fathoms deep, which were considered very unfavorable conditions. During the run, the total indicated horse power was 15,000 out of a guaranteed 20,000. The maximum revolutions of the engine were 120. Her steering qualities were of the first order. The *Columbia* was then returned to be put in order for her official trip that takes place off Long Island.

Two New English Battleships.—The Navy estimates for 1893 and 1894 provide for two first-class battleships, to be called the *Majestic* and *Magnificent*, which are to be built at Portsmouth and Chatham. Their principal dimensions are as follows: Length, 390 ft.; breadth, extreme, 75 ft.; mean draft, 27½ ft.; displacement, 14,900 tons. With natural draft on the eight-hours contractor's trial a mean speed of 16½ knots is anticipated; with moderate forced draft a *maximum* speed of 17¼ to 17½ knots will be obtained. The armament will include four 12-in. breech-loading guns of new type, mounted in pairs, twelve 6-in. quick-firing guns, sixteen 12-pdr. quick-firing guns, and twelve 3-pdr. There will also be five torpedo discharges for 18-in. torpedoes, four of these being submerged.

Oil-Distributing Sea Anchor.—A cheap and simple device which may prove to be of especial usefulness to fishing vessels in a sea way is an oil-distributing sea anchor, recently invented. It consists of a triangular frame of wood cross-lashed at angles and provided with a span of three legs. Across the interior triangular space of the frame is stretched a piece of canvas, fitted with eyelet holes and laced through these eyelet holes to the frame. To back and support the canvas a piece of netting is laced to the frame. In the middle of the canvas is a patch, to which is stitched a bag consisting of two thicknesses of canvas. The space between these bags is the oil chamber. At the trailing end of the outer bag a simple valve may be placed, or the outer bag may be perforated with sail needles. A towline from the vessel is bent to the span. A simple rubber hose or tube connects with the oil chamber and leads to the vessel, being seized to the towline at intervals so as to insure its being kept slack while the towline is under tension. On board the vessel a pump or bulb syringe is employed to feed the oil into the oil chamber of the distributor as may be desired. For fishing vessels the device may be kept attached to the anchor by a rope of sufficient length to insure that the device shall be awash when in use. The device can then be streamed when the anchor is let go. The anchor may be of any size, and offers a wide field of usefulness.—*Baltimore Journal of Commerce.*

Regularity of the Turning of Steam Vessels.—The loss of the *Victoria* has attracted attention to the behavior of vessels under various evolutions, and Admiral Coulomb has made a statement in regard to the accuracy of the *Edinburgh's* movements. In a test her turning powers were measured so as to fix her position at the moment the helm began to move, and when she had turned an eighth, a quarter, three-eighths, and a half circle. She was turned three times to the right and three times to the left, under the same conditions, at a normal speed of about 12 knots. The result was that, including all errors of observation, chords drawn from the point of starting to the points given above did not vary in length for the eighth of a circle turn more than 22 yds. in 335; for the quarter-circle, more than 25 yds. in 565; for the three-eighths of a circle, more than 25 yds. in 687; and for the half-circle, more than 64 yds. in 716. The angles that the chords formed with the original course of the ship did not vary, for the first chord, more than one degree in 13; for the second chord, more than two degrees in 33; for the third chord, more than two degrees in 53; and for the fourth chord, more than two degrees in 75. As to the times occupied, the accuracy is, perhaps, still more remarkable. The ship turned the eighth of a circle in 66 seconds, with a variation of only three seconds; she turned the quarter of a circle in two minutes and one second, with a variation not exceeding five seconds; she turned the three-eighths of a circle in two minutes and 58 seconds, with a variation not exceeding seven seconds; and she finished the turn of half a circle in three minutes and 54 seconds, with a variation not exceeding eight seconds of time.

Two British Cruisers.—Two British cruisers, to be called the *Powerful* and *Terrible*, have recently been designed, and they are to be the largest cruisers in the world. Their principal dimensions are: Length, 500 ft.; beam, 75 ft.; mean

draft, with keel, 27 ft.; displacement, about 14,000 tons. The continuous sea-steaming speed is to be 20 knots an hour. On an eight hours' natural draft contractor's trial the speed will be about 22 knots an hour.

The hulls of the two ships will be steel, wood sheathed and coppered. It is proposed that the ships shall be able to take the sea and keep it for long periods, and in order that neither shall suffer in speed for want of coal, the designs call for a coal supply of 3,000 tons for each ship. On the 14,000 tons displacement and 27 ft. draft called for in the designs a coal supply of only 1,500 tons a ship is considered. The bunkers, however, will hold 3,000 tons of coal.

The battery of each ship will consist of two 9.2-in. breech-loading rifles mounted, one in the bow and one in the stern, as chasers, twelve 6-in. rapid-fire guns in broadside, eighteen 12-pdr. rapid-fire guns, twelve 3-pdr. rapid-fire guns, and a number of small machine guns. The 6-in. rapid-fire broadside guns will be in such a position as to permit four guns to be fired right ahead and four right astern.

Armor protection will be provided for all the 9.2-in. and 6-in. guns. The 12 pdr. guns on the upper deck will be furnished with strong shields revolving with the guns. The torpedo armament will consist of four submerged torpedo discharge tubes placed in two separate compartments. The engines, boilers, magazines, and other vital portions of the ship will be placed below a strong curved steel deck, having a thickness of 4 in. for a large proportion of the length, with a slight reduction of thickness toward the extremities. This deck will be associated with minutely subdivided coal bunkers extending up to the height of the main deck. This latter feature is identical with that seen in all the late first-class cruiser designs for the British Navy.

Battleships for the French Navy.—The plans of the French Admiralty for 1894 include the laying down of three new first-class battleships, each of 12,000 tons. The designs for these new vessels are not yet quite completed, but they are to be protected by a belt of armor the greatest thickness of which will be 45 cm. (17½ in.). Instead of the usual splinter-protective deck below the armored deck, a second armored deck is to be introduced. It is understood that the center batteries will consist of 30-cm. (11.7 in.) guns, and the auxiliary batteries of 16-cm. (6¼ in.) and 10-cm. (3.9 in.) quick-firing guns, and that there will be a very full complement of the lighter guns It is also intended to fix the torpedo-launching apparatus below water. The system of two turrets, each carrying two guns, as practised in England, is to be adopted. The turrets are to be revolving and covered. The guns of medium calibers are not to be placed in turrets in pairs, but singly, behind protective shields, 72 mm. (2.8 in.) thick. The operations of revolving the turrets, serving the guns, and supplying ammunition are to be effected by electricity, the apparatus to be adopted being that used in the *Capitan Prat*, which has proved very effective. It is most likely that the machinery, boilers, etc., will be placed in three separate compartments, and that the new vessels, like the *Dupuy de-Lôme*, the *Massena*, and the *Bouvret*, will be provided with three screws. With forced draft, a speed of 18 knots is to be attained. If the French Chambers approve of the outlay, concerning which there appears to prevail but little doubt, France will possess, in 1894, nine new battleships in various stages of completion, including the *Brennus* and *Bouvret*, which are being constructed at L'Orient; the *Charles Martel*, at Brest; the *Jauréguiberry*, at La Seynes; the *Lazare-Carnot*, at Toulon; the *Massena*, at Saint Nazaire; and the three new vessels mentioned. Of the ships named, only the *Brennus* has so far been launched; but their completion is to be expected in the following order: *Brennus, Jauréguiberry, Charles Martel, Lazare-Carnot, Bouvet,* and *Massena*. One of the new vessels is to be built at a private yard, the other two being laid down in government dockyards. —*Times*.

New French Cruiser.—A new cruiser, the largest in the French Navy, is ordered to be built at La Seyne, after designs by M. Legane, the constructor of the Spanish battleship *Pelayo*, the Chilian armored cruiser *Capitan Prat*, and other celebrated modern vessels. She will be named the *D'Entrecasteaux*, after the famous navigator who died during his search for La Pérouse, and, as she is intended for service as flagship in distant seas, she will be sheathed and coppered. Her displacement will be 8,114 tons; her length at the water-line, 393 ft. 6 in.; her extreme breadth, 58 ft. 5 in.; and her extreme draft, 29 ft. 6 in. She will have two vertical triple-expansion engines, with five cylindrical boilers, developing in all 14,000 H.P., and giving a speed of 19 knots. The normal bunker capacity is to be 650 tons, but it will be possible to carry 1,000 tons of coal. The protection consists of a 3.9 in. steel deck, with, above it, a great number of cellular compartments for coal and stores, the whole being covered by another steel deck ⅞ in. thick. The whole of the hull below the protection is occupied by the machinery, boilers, bunkers, and magazines. Each of the heavier guns has its own separate ammunition hoist. These, and also all the auxiliary machinery, steering-gear, internal lighting, loading and training engines, etc., will be electrical. The armament will consist of two 9.4 in. guns of 40 calibers; twelve 5.5 in. quick-firing, twelve 1.85 in. quick-firing, and four 1.45 in. quick firing, with two submerged and five above-water torpedo tubes, two of the latter being in the bows. Each of the 9.4 in. guns will occupy a closed turret covered with 9.8 in. steel. Four of the 5.5 in. quick-firing guns will be on the spar-deck behind 2.8 in. hardened steel shields, and the remaining eight upon the main deck in sponsons behind similar shields. The smaller guns will be distributed over the superstructure and in the tops, of which there will be three—or, rather, a three-decked one—on each of the two military masts. Within the masts there will be the usual staircases and fighting positions, and there will be also a heavily armored conning tower. The *D'Entrecasteaux*, which is estimated to cost $3,017,230, will be somewhat larger than our new first-class cruisers of the *Edgar* and *Crescent* classes, but a little smaller than those of the *Blenheim* type. She will also be exceeded in size by the Russian cruiser *Rurik*, than which, however, she will be a knot faster. In size she will most nearly approximate to the new American cruiser *New York*. Another ship of the class is to be laid down presently.—*Engineering*.

Tail Shaft Preserver.—Mr. T. Mudd, of the Central Marine Engine Works, West Hartlepool, has recently fitted to the propeller shafts of several steamers engined at these works an arrangement for preventing the galvanic action which arises immediately at the ends of the brass liners when immersed in water, and the general corrosive action that proceeds along the middle part of the shaft between the liners when exposed to salt water in the stern tube, and which is aggravated by the churning action produced resulting in the water being largely mixed with atmospheric air. Mr. Mudd holds that the one great essential to be aimed at is keeping the water away from the shaft. This has been attempted in several ways, such as by lengthening out the liners till they meet, and there brazing them together, but he believes it has never been effectually accomplished, and the covering of a shaft with brass all over is a very expensive expedient. Mr. Mudd's patent tail shaft preserver then consists simply of a tube or sleeve, made of first class india-rubber, of such dimensions as to cling tightly to the shaft over the whole length between the liners, and for several inches up the inclined liners at its ends. For this purpose the liners are lengthened out about 6 in. more than is usual, and gradually tapered away to accommodate the elastic sleeve. This gentle tapering of the liners has another good effect, as it gradually diminishes the strength of the liner, and so overcomes the objection to a sudden change of strength where the liner finishes, and which, doubtless, in many cases aggravates the damage caused by galvanic action at that point. When the preserver is to be put on the shaft, the latter is thoroughly cleaned bright, and coated with a suitable cement, and by means of special apparatus of a simple character the sleeve is drawn over the end of the shaft until it is in its place, where it becomes embedded firmly in the cement, clinging so tightly as to make the accession of water beneath it quite impossible. When desired, the ends may be lashed with copper wire over wire gauze, and the lashings soldered together. To prevent any chance of the sleeve being damaged when the shaft is being pushed into its place in the tube, a false nut is provided which runs on the thread on the end of the shaft, the external diameter of which is precisely the same as the diameter of the brass liners, and which therefore holds up the point of the shaft as it passes through, preventing the elastic tube from being injured by the neck bush. This nut, of course, goes with the ship as part of the outfit.—*Journal of American Society of Naval Engineers*.

NOTES AND NEWS.

A High Smoke-stack.—One of the highest, if not the highest smoke-stack in the United States has been recently built for the Fall River Iron Company. The stack from the top of the granite foundation to the cap is 350 ft.; the diameter at the base is 30 ft., at the top 21 ft.; the flue is 11 ft. throughout, and the entire structure rests on a solid granite foundation 55 ft. by 30 ft. by 16 ft. deep.

The Trajectory of a Big Gun.—At a test of the coast gun built by Krupp, at the Meppen proving grounds recently, the projectile was fired 65,616 ft. with the gun having an ele-

vation of 44°. The projectile weighed 474 lbs. and a charge of 253 lbs. of powder was used, giving an initial velocity of 2,099 ft. It is estimated that the projectile reached an altitude of 21,456 ft., its flight occupying 70.2 seconds. The Krupps have had a drawing made showing the flight of the projectile relatively to Mont Blanc, in which it is shown that it would be possible for the gun to fire over the mountain from Pre-St.-Didier.

The Gordon Disappearing Carriage.—The Gordon disappearing carriage for the 10-in. breech-loading rifle was tested at the Sandy Hook proving grounds on September 13. The firing was to sea, and little delay was caused by shipping. The record was for 10 rounds, and the last six rounds were fired continuously. Without any deduction of time for delays, the 10 rounds were fired in 59 minutes and 24 seconds. The carriage was worked by hand throughout, the design being independent of power appliances of any kind. The carriage worked remarkably well during the whole test. Full service charges were used, the weight of powder being 250 lbs., and that of the projectile 575 lbs.

Electric Feeder for the Gatling Gun.—A new electric feeder has been applied to the Gatling gun by its inventor at Hartford, Conn. On a strip of tin, 20 smokeless powder cartridges are placed, each held in place by bits of tin turned up for the purpose. These strips are put into a horizontal opening, and as they are drawn through, the cartridges are stripped off and placed in position to be thrust into the chambers. The motion is positive, and there is no failure in any part of the movement. The strips with cartridges attached can be compactly packed, and a much larger amount of ammunition can be carried with the gun than by the old way. The gun can be fed by these strips with the greatest rapidity. With them it has been fired 3,120 times in a minute, and when turned by a little electric motor attached to the breech, it can be fired 5,000 times a minute.—*Electrical Review.*

A New Smokeless Powder.—According to reports from Bucharest a new smokeless powder, known as Plastomenit, has been tested there by the military authorities as well as by the local sporting club. One of the advantages it is said to possess over other similar powders is that its combustion does not choke the gun. Though it proved to be the best of smokeless powders yet tried for the small caliber Mannlicher rifle in use in the Roumanian Army, the results with that weapon were not quite satisfactory. It was, however, found to be everything that could be desired in the matter of carrying power and penetration with the smooth bore guns of the Sporting Club, and is said to be equal, if not superior, to powder of English manufacture. The smoke is hardly perceptible, and the noise of the explosion is very slight, while there is absolutely no recoil.—*London Times.*

Thirteen-in. Gun for the United States Navy.—Considerable attention has been attracted lately to the 13-in. gun which is soon to be tested at the Indian Head proving grounds. It weighs 135,500 lbs.; its total length is 40 ft., and the greatest diameter of the gun body, 49 in. The total length of the bore is 37 ft. 10 in., of which 30 ft. 10 in. are rifled. The rifle consists of 52 grooves, each .415 in. wide and .05 in. deep. The chamber capacity of the bore is 80 in. long, with a diameter of 15 in. The total capacity of the bore is 64,857 cub. in. The shot that it will throw weighs 1,100 lbs., and 550 lbs. of powder will be required for each firing. The muzzle velocity of the projectile will be 2,100 ft. per second. It is also estimated that after traversing a distance of 2,500 yds. the shot will still have a velocity of 1,805 ft. per second. The energy at the muzzle is estimated at 33,627 foot tons. It is expected to have a penetrative power of 24 in. of steel at 1,500 yds. from the muzzle. Brown's prismatic powder will be used in the first test.

Automatic Block Signaling by the Use of Incandescent Lamps.—The Weehawken tunnel of the West Shore Railroad, in New Jersey, which is 4,200 ft. in length, has been fitted with a novel block-signal system, described in the *Engineering Magazine.* The arrangement consists of a line of incandescent electric lamps about 300 ft. apart, and placed on a level with the eye of the engine-driver. When the lamps are all alight it is an indication of safety. Each train passing through extinguishes the lamps for a distance of 1,100 ft. in its rear, a result which is automatically effected by an electrically connected track circuit, whereby the lamps are kept under the continuous control of the train. The operators in the signal towers at each end of the tunnel can also extinguish the lights in any section of the tunnel if occasion requires. This system appears to embody a number of exceedingly valuable features, and, if successful in practice, cannot but increase the traffic capacity of a long tunnel largely beyond that which is possible by the methods of signaling heretofore in use.

Test of Holtzer Projectiles at Sandy Hook.—A test of the 300-lb. Holtzer projectile of American manufacture was made at Sandy Hook on September 5. Two shots were fired, one of which was recovered and the other lost, having gone seaward, although it is hoped that it will be picked up on the shore. The one which was recovered was sent through 9 in. of solid steel backed by 3 ft. of solid oak, and was found 20 ft. back of the oak in solidly packed sand, and was declared by experts to be practically as perfect as when it had been inserted in the breech of the 8-in. rifle. The projectile is made by the Midvale Steel Company, who has purchased the right to manufacture for the whole American Continent from the Holtzer Company of Umieux, France, who control a secret process invented by C. E. Brustlein, for making steel as hard as flint at the same time as tough as copper. When the projectile which was recovered was brought to the surface, it was found that the upset was only .005 of an inch. The initial velocity of each shot was 1,624 ft. per second with the pressure of 23,260 lbs.

Heat of the Sun's Surface.—What is the actual heat of the sun's surface? Various estimates have been made, but as they vary from 1,000 and a fraction to millions of degrees there is little prospect of an immediate and reliable answer to the question. Secchi gave it as his opinion that the temperature could be but little, if any, short of 10,000,000 degrees of the Centigrade thermometer. Sporer thought that it might be 37,000 degrees, while Pouillot brought it down to somewhere between 1,400 and 1,761 degrees of the same scale. M. Becquerrel, Professor Langley and Sir William Thompson all agree on about 3,000 degrees of Centigrade, making their deductions from calculations based on solar photospheres.

According to M. St. Clair Deville, the temperature of the sun's surface does not exceed 2,800°. This also agrees with experiments made by both Bunsen and Debray. Sir Robert Ball, the astronomer royal of Ireland, in his "Story of the Heavens," says: "We shall probably be well within the truth if we state the effective temperature of the sun to be about 18,000° F."—*St. Louis Republic.*

Hydraulic Pump for Mines.—In a new hydraulic pump arrangement just being introduced in some of the English collieries, two columns of water are substituted for the ordinary pumprods connecting the steam-engine with the pump, and which may be placed any distance from each other. Advantage is taken of the fact of water being practically incompressible, and that if a pipe is filled with water a piston at one end will, if pushed forward, propel a piston placed at the other end in the same direction; with two pipes and four pistons a reciprocating motion is obtained. The arrangement consists of a hydraulic cylinder in which works a piston or ram, called the power ram, which is moved by a crank driven by a steam-engine. At the pump there is a cylinder exactly the same as that at the engine, in which is a piston or ram attached to the plunger of a double-acting pump, and a pipe connects the end of the power cylinder at the engine with the end of the motor cylinder at the pump. When both cylinders and pipes are filled with water and the water piston is moved by the engine, the water in the power cylinder is forced through the pipe into the end of the motor cylinder at the pump, and the motor piston is moved. In a like manner, when the power ram at the engine moves that at the pump responds, carrying the pump plunger with it. Thus the pump plunger is moved backward and forward in the same way as if there were a direct connection by means of rods between the steam engine and the pump.—*London Press.*

The Mont Blanc Observatory.—This observatory, which was completed in August, stands 15,781 ft. above the level of the Mediterranean, and is the result of two years' toilsome and dangerous labor by 40 men, who have risked their lives for the benefit of science and mankind. The question arose prior to building as to whether a rock foundation could be had, and in order to determine the fact a tunnel was driven through the ice a distance of 135 ft. on the south side of the peak, 50 ft. below the summit. Finding nothing but sound ice, an incline shaft of 130 ft. was sunk with no better result. An ice foundation was the only choice left, and upon the ice the observatory has been erected. The peak upon which it stands is 126 ft. long and 48 ft. in width. To avoid the disturbing effect of the furious storms which sometimes rage on the summit, the building, as will be seen from the framework shown in the figure, has the form of a truncated cone and is in two stories. The lower story is below the ice crust, about 20 ft., and the upper 18 ft. above the surface. There are six rooms in all, one of which will be reserved for visitors, who will be entertained free of charge during their stay on the summit. The building is supported underneath by jackscrews, so that in the event of its moving from position it can

be screwed back to its place. The rooms are heated by petroleum stoves. The outside temperature in the winter is 40° below zero and about 12° above in the summer. The total cost of this extraordinary undertaking, when completed in August, will reach $60,000. The telescopes and other scientific instruments first used will be of a smaller caliber, as it is necessary to make experiments before buying large and expensive ones.

Submarine Foundations Made by Solidifying Sand.—At the recent World's Congress of Engineering in Chicago, Dr. Neukirch described a method of solidifying sand in the bottom of a river by converting it into a concrete masonry foundation without being excavated or disturbed. The process consists in using air pressure to force dry powdered hydraulic cement through a pipe down into the bed of sand or gravel. The pipe or tube has a lance-shaped foot perforated with small holes through which air is forced. The pipe is sunk deep into the sand and gravel bed by forcing air through these holes, which displaces the particles of sand at its foot and allows it to settle. When the tube has reached a solid substratum the cement is fed into the tube, and the current of air carries it to the foot of the tube, and injects it with considerable pressure into the sand and forms a matrix with the sand, gravel, and water present. The blowing in of the cement and air in this mobile mixture produces a boiling action at the end of the tube which thoroughly mixes the cement and sand. As the process goes on and the introduction of the cement continues, the tube is slowly drawn up at a speed which permits the required quantity of cement to be introduced. As the tube is drawn up and the injection of the air ceases, the grains of sand subside and settle firmly together, occupying a smaller space than before the cement was introduced. Each sinking of the tube gives, of course, only a column of concrete, its size depending upon the pressure of the air and the looseness of the sand. To insure the solidity of the whole foundation, the pit is divided into small fields from 8 to 12 in. square, and into each field the pipe is sunk and the requisite quantity of cement forced. To limit sharply the lateral dimensions of the foundations and to protect it against outside influences, it is in the first instance surrounded with sheath piling or a cofferdam.

The Most Suitable Colors for Signal-posts and Semaphore-arms.—Attention is directed to the difference in opinion which is prevalent with respect to the coloring of railway signals, upon the facility of recognizing which so much depends. There is no desire to question the advantages in favor of the two colors, red and green, which have so long been selected for night signals; it is, however, pointed out, that while the red glasses used for this purpose are, as a rule, admirable, the green glass is frequently of too dark a shade, which renders it impossible to distinguish the light at a distance of more than 330 yds. to 440 yds. In lieu of green glass, it is advisable to substitute the pale, bluish glass, long employed at sea, which transmits a beautiful green light, capable of being seen as such at great distances. This so-called "marine glass" is already in use by some railway companies. In accordance with the new (German) regulations, which came into force on January 1, 1893, red and green disks are to be partly used for day-signaling; and provision is made for keeping them free from dust and dirt, and for repainting them at frequent intervals. It must be determined by time whether enamel colors or "durable" paints prove to be the best for this purpose. All kinds of theories exist as to the best manner of painting the posts and movable portions of the signals, so as to render them readily visible to the engine-driver under all circumstances; and it is time that some definite rules, sanctioned by long experience, were laid down to secure uniformity in this respect. In the investigation of a series of cases where complaints have been made, it has been found that the red color commonly used for the semaphore arms becomes, under certain conditions, extremely difficult to distinguish—namely, when it is seen against a background of foliage. In a given instance the arm was painted white, which gave satisfaction for a time, but as soon as the brilliancy of the new paint had disappeared, and the signal had to be made out in snowy weather on a white background, matters were as bad as ever, so the semaphore was painted red as before, with renewed complaints in the following summer, when the trees became green again. The color, as it deepened with age, was found more and more difficult to make out, and the signal-arm soon had to receive a second coat of paint; it was, however, decided that the red color was more clearly visible than in the year before, when the arm was painted white. Though this represents an individual case, it is a matter of wide experience among railway officials, and arguments are founded upon it against the practice of coloring the arms in alternate stripes of red and white, either horizontal or vertical in direction, as tending to reduce the area of visible color. This does not apply to the posts, which are best painted in bands of black, white, and red, beginning at the bottom with black, in belts about 3 ft. to 4 ft. deep. The following regulations, based upon a practice of many years in duration and extending over a great mileage of railways, are proposed:

1. The semaphore-arms are, as a rule, to be painted bright red throughout their entire surface. In a few rare and exceptional cases all black or alternate cross-bars of white and red may be used, the white stripe to be next the post and red to follow.
2. The color of the arms must be renewed as frequently as may, in special cases, be requisite.
3. The signal-posts themselves are to be painted in alternate bands of black, white, and red, from the base upward.—*Annalen für Gewerbe und Bauwesen.*

A New Method of Casting Steel Ingots.—At the Nykroppa Ironworks, in Sweden, a method of consolidating steel ingots, by subjecting the freshly filled mold to pressure developed by centrifugal action, has been introduced by the manager, Mr. L. Sebenius.

The apparatus consists of an upright shaft in the center of a cylindrical casting pit, carrying a frame of four arms, to each of which is articulated a platform supporting four ingot molds. While the shaft is at rest, the molds are upright, and are filled in the usual way; but when it is set in rapid rotation they fly up into the horizontal position, and a pressure in the direction of the length of the ingot is developed equal to thirty times that due to the column of liquid metal in the mold, which drives the gases out, and produces a perfectly solid casting. Uniformity of composition is also induced, as, on account of the rapid cooling, liquation is prevented. The process, which has now been in use about two years, has been applied to both the Bessemer converter and to the open-hearth furnace. The ingots are free from external defects, and the loss by defective ends has been diminished 40 per cent., the metal being so compact as to bear rolling to finished sizes without the use of the cogging mill. The cost of the apparatus is about £400 for a three-ton and £800 for a ten-ton charge.

No details of the apparatus are given, except in the accompanying figures, from which it appears that the circumference described by the bottom of the molds, when spun up into the horizontal position, is about 67 ft., corresponding to the working speed adopted of 125 revolutions to a velocity of nearly 10,000 ft. per minute. The pressure on the mold, taken at thirty times the depth of the ingots, will be about 150 ft. of iron, or from 500 lbs. to 600 lbs per sq. in. In the form of the apparatus intended for smaller ingots the molds are arranged in an inclined position, and radially to a central fixed vertical feeding tube upon a turntable, which is set in rotation after filling, or the latter operation may be performed while the table is actually in motion.

The second notice contains figures of a modification of the apparatus, in which the rotating table, being smaller in diameter than that previously adopted, can be driven at a higher speed, up to 200 revolutions per minute. There are eight pivoted molds, each divided by internal walls, so as to give nine small ingots, suitable for wire billets or thin sheets. By means of a central annular funnel, lined with refractory material, and provided with eight feeding spouts, or one for each group of molds, the whole number of 72 ingots are cast by a single pouring from the ladle, which contains from four to six tons of steel.—*Proc. Inst. of C. E.*

A Persian Telegraph Line.—The mode in which telegraph lines in Persia under native control are erected and worked is described by the British Consul at Resht in reference to the line between Enzelli, on the Caspian, and Resht, and Teheran. In dry weather, he says, the line works fairly well, but in damp or rainy weather it cannot be counted upon. The reason is that the insulators are driven into trees that have branches growing round the hooks and touching the wires, thus intercepting the current if the tree is a large one; but when a large tree is not available a small one is used, and this often breaks, or the shaking of the slender tree by the wind dislodges the insulator or hook on which it is fixed, and the wire trails on the ground. The Consul has often seen the wire right across the high road, which is followed by hundreds of mules both in Ghilan and Astrabad, not only interrupting telegraphic communication, but endangering the lives of the animals and their riders, more especially when the accident happens on the brink of a precipice. It is not surprising, under these conditions, that telegrams in Persia are not received punctually. In one case a high foreign official telegraphed to Teheran from Europe announcing his intended arrival at Resht

in a fortnight. The telegram was received at Teheran the same day by the European line and immediately dispatched to Resht by the Persian line. The fortnight elapsed and the high official arrived. The telegram was received in the sender's presence 18 days after its dispatch. With regard to telegraphic communication through the Persian lines, as all messages are received on the instrument by "ear" and no "tape" record is kept, mistakes almost always occur when the message is in cipher, also when figures, such as sums of money, are mentioned or foreign words or names are transmitted.—*London Times.*

Singular Drainage Arrangements.—A peculiar combination of circumstances has resulted in a remarkable drainage system being employed in a coal mine near Sykesville, Pa. The company owning the coal land also operated a railroad running near the place where the seam of coal cropped out, which made it desirable to begin mining at that point. The seam of coal sloped down from this outcrop to a place about two miles distant in a straight line, where it began to rise again. The surface of the ground over this low point was 116 ft. above the bottom of the seam of coal, and considerably lower than the elevation of the point where the seam came to the surface. It was decided to sink a vertical shaft to the lowest point of the coal, and then tunnel from the foot of this shaft up through the inclined bed to meet a tunnel driven from the point of outcrop. The vertical shaft was 12 × 16 ft. in cross section, and was provided with two pumps capable of removing about 1,250,000 galls. in 24 hours. After nearly three years of work the tunnel down through the coal seam was completed. It is 9,100 ft. long and about 9 ft. wide, the height depending on the thickness of the coal. When it was completed it was found that a horizontal plane through the top of the vertical shaft would cut the tunnel about 4,600 ft. from the outcrop, and so it was decided to discontinue the use of the pumps in the shaft and allow the lower half of the tunnel to fill with water, which would be prevented from rising more than 4,600 ft. from the end by the free overflow it would have at the top of the shaft. The shaft is now full and overflowing, and in this way 2,500 acres of coal land are being drained without any expense for pumping. As soon as all the coal is mined out above this water level, which will probably be many years hence, the water can be pumped out and the remainder of the territory mined.

A Safe for Express Messengers.—An invention to balk train robbers has been devised by E. B. Pope, Western Agent of the Chesapeake & Ohio Railway at St. Lous, and he has applied for a patent upon it. The scheme provides for equipping every express car safe with two locks, which interlock with each other. Lock No. 1 can be either an ordinary key lock or a combination lock. In either case the messenger can handle his money packages for the way stations the same as under the present system. Lock No. 1 is connected with lock No. 2 by a small steel bar, which works in and out of the combination lock No. 2 as the messenger locks and unlocks lock No. 1; the tumblers in lock No. 2, when in their normal position, being always set at "open" and held in that position by a simple mechanism to prevent the jar of the train or an accidental knock from throwing them out of position and locking lock No. 2. A metal cover hinged to the safe fits closely over the dial plate of lock No. 2, and is fastened with a small padlock when the safe is not in use to prevent maliciously disposed persons from causing trouble by throwing off the combination of lock No. 2. When he starts on his trip the messenger unlocks the dial cover and swings it back out of the way, leaving him free to throw off the combination of lock No. 2 when the alarm is given. The messenger knows the combination of lock No. 1 or has a key to unlock it, but he does not know the combination of lock No. 2, and if he once throws off the latter it is impossible for him to unlock and open the safe. A notice is painted on the outside of the safe, instructing the messenger to throw the combination of the lock No. 2 in case of assault by robbers. The inventor says that any two combination locks, or one key lock and a combination lock, can be connected together at small expense so that they will work in unison, and the present stock of safes and messengers' chests now in use can be cheaply equipped with the new device, although it would probably be found desirable to make a quality of messengers' chest that would be too heavy to carry off and strong enough to successfully resist anything but a long and persistent attack by professional safe blowers. —*Railway Age.*

Agricultural Implements in Sicily.—Agriculture is yet in its most primitive state throughout the island. No new inventions, no labor-saving machines, have found a place in Sicily, nor is any appliance known that was not in use generations—in fact, ages—ago. Wheat and oats are harvested, principally by women and children, with the sickle, and the grain is tramped out by horses and donkeys. There is not a reaping, mowing, or threshing machine in this entire district. The plow used by the farmer to-day, incredible as it may seem, is the wooden stick, the round iron point, the long beam extending from the point and resting on a yoke across the necks of donkeys. In Sicily, however, the plow divides honors with the hoe, as only about one-half of the agricultural area is plowed, the other being broken by hand with the hoe. This hoe, with blade 10 in. to 12 in. long by 5 in. wide, and heavy handle about 2 ft. long set at an angle to the blade of about 45°, is the universal work tool of the Sicilian. With it the farmer's land is broken and crops cultivated. Irrigation and ditching, as well as street and road construction, are done with this crude implement. That there is dire necessity for better farm implements and for such tools as the shovel, spade, fork, and wheelbarrow is most evident; but that their introduction here is probable, or that these people could be induced to discard the old and take up new tools, is extremely doubtful.

There is believed to be an opening here, however, for American manufactures of various kinds, such as threads and certain cotton textiles, lamps, small stores, hardware, office furniture, and stationery, provided color, weight, size, etc., together with the peculiarities of the trade and business customs, are considered and catered to. Three-fourths of the manufactured articles bought in this market are supplied by Germans, for the reason that both American and English manufactures are too heavy and expensive. The German learns this by coming here and ascertaining what is most salable and then manufacturing his wares to meet the requirements of the market. Yet in many instances he represents his article to be of American manufacture, or that it is made after American designs. That such representations aid him in his sales fully demonstrates the fact that the people here recognize the superiority of American manufactures, and it is believed that this would facilitate their introduction; but to avail ourselves of this market, its peculiarities and conditions must be known, and this can only be accomplished by sending capable representatives here. The statement should be emphasized that price-lists and circulars sent to addresses obtained from consuls are never productive of good results.—*U. S. Consular Reports.*

When Coal was First Used.—Though coal had been employed for centuries in the manufacture of salt on the shores of the coal fields, wood had hitherto continued to be the fuel at the inland salt works. The use of coal at Nantwich is mentioned as a novelty in 1656; at Droitwich wood fuel and leaden pans were in use up till 1691. In this era the sea salt manufacture was in the zenith of its prosperity. But the substitution of coal for wood in the inland salt trade, aided by the discovery of rock salt, which took place accidentally in boring for coal in Cheshire, led to the gradual decline and final extinction of the manufacture of salt on the coast. The only traces now remaining of this once flourishing industry exist in such names as Howdon Pans on the Tyne, Prestonpans on the Forth, Saltcoats in Ayrshire and Saltpans in Arran and Kintyre, or in the Scottish proverb, "Carry salt to Dysart," synonymous with the English "Carry coals to Newcastle."

In no branch of industry was the scarcity of wood more keenly felt than in the smelting of metalliferous ores. Continued efforts to accomplish this with coal began immediately after the accession of James I., and were persevered in throughout the seventeenth century. But for a prolonged period the new fuel proved highly intractable, and scheme after scheme ended in failure and disappointment.

After eighty years of oft-repeated trials the tantalizing problem remained unsolved. Wood and charcoal still held the field in the smelting furnaces, and all hope of ever seeing coal substituted for them had well-nigh died out. In 1683 Sir John Pettus, in his "Essays on Words Metallick," concludes his observations regarding sea coal and pit coal with the remark, "These are not useful to metals."

The unpromising prospect, however, soon began to brighten. Immediately after the revival of lead and copper mining, which took place about 1692—having probably been more or less in abeyance through the interruptions occasioned by the civil wars—these ores came to be smelted with coal. The extraction of silver from lead with coal was accomplished by a Mr. Lydal in 1697, and the same individual appears to have been the first to successfully employ coal in the smelting of tin, in 1705.

The ores of iron proved more refractory, no substantial and permanent success in smelting them with coal being obtained till near the middle of the eighteenth century, when the manufacture of charcoal iron had dwindled to very small proportions—in fact, was dying out for want of fuel.

It then at length became an accomplished fact at Coalbrookdale Ironworks in Shropshire. The success was at first ascribed to the Shropshire coal; but probably the employment of a strong blast had a great deal to do with it. From this the coal became the life of the iron manufacture. The *ci-devant* drooping trade rapidly revived, and the latter part of the eighteenth century saw coal iron furnaces in successful operation throughout the kingdom. —*Contemporary Review.*

AMERICAN AND ENGLISH LOCOMOTIVES.

(*Continued from page 420.*)

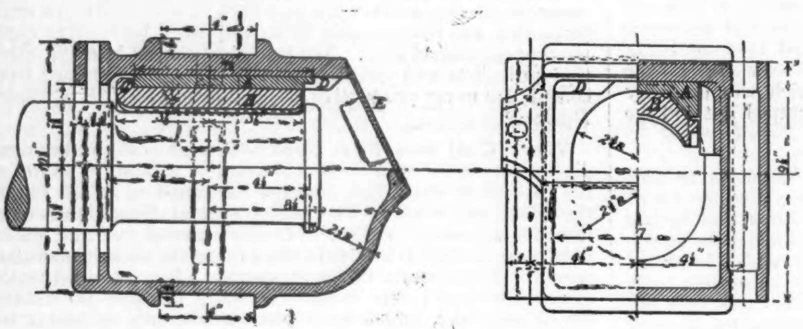
The parts of the locomotives which are illustrated this month are the tender frames and running-gear, of which the following are the specifications for the American engine :

TENDER FRAME.

Substantially built of 6¼ × 4¾ in. angle iron and thoroughly braced. The back end to be fitted with "Gould" coupler.

TENDER TRUCKS.

Two four-wheeled side bearing trucks made with wrought-iron side-bars and wood bolsters.



TENDER OIL-BOX FOR AMERICAN EXPRESS PASSENGER LOCOMOTIVE.

SPRINGS.

Made of best cast steel, tempered in oil.

WHEELS.

Krupp's steel-tired plate wheels, 36 in. diameter. Tires held by retaining rings.

AXLES.

Of hammered iron, with outside journals 4¼ in. diameter and 8 in. long. Brakes on front truck only.

The specifications for the corresponding parts of the English engine are as follows :

SIX-WHEELED TENDER.

Principal Dimensions.

	Ft.	In.
Diameter of wheels on tread	3	9¾
Center to center of journals	6	6
Length of journal	0	9
Diameter " "	0	5¼
Diameter of axle in wheel	0	6¾
" " " at center	0	6¼
Wheel-base	13	0
Length of frame	19	9½
Total length of wheel-base, from center of leading bogie wheels of engine to center of hind wheels of tender	44	3½
Length over all, from front buffers of engine to hind buffers of tender	53	8¾
Height of center of buffers from rails	3	5

TENDER FRAME.

The frame-plates, cross-stays, stretcher-plates, hind buffer-plates to be of steel, same quality and manufacture in every respect as specified for the engine main frames.

Each frame is to be made of one plate, ¾ in. thick, and all holes are to be marked and drilled from one template. The axle-box guides are to be made of cast iron, planed, fitted, bolted to frame, and must be free from cross-winding and square with the frames in all directions. The horn-stays are each to consist of two 1⅛ in. bolts with cast-iron distance pieces accurately fitted between the horns. All the cross-stays are to be accurately fitted to the frames and riveted to them by ⅞-in. diameter rivets. The frames are to be accurately tested by longitudinal, transverse and diagonal measurement, and must be perfectly parallel to each other. The front buffing and draw-beam is to be constructed as shown, and is to be provided with buffers fitted with volute springs to this company's pattern. The draw-bar is to be forged in one, the hole at one end being punched. Wrought-iron steps are to be provided, roughed and fixed where shown. The hind buffing and draw-plate is to have a draw-hook and bar furnished with one of Spencer's No. 6 india-rubber cylinder to this company's pattern, two cast-iron buffers the same as specified for the engine, two side chains and screw coupling made of best chain cable iron, and to drawing. Two steel life-guards are to be bolted to the frame, behind the hind wheels.

AXLE-BOXES.

The axle-boxes are to be made of cast iron fitted with a wrought-iron top, and with the best gun metal bearings lined with Dewrance's anti-friction metal, and to have cast-iron keeps provided with lubricating pads. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle-journal to give clearance; front and hind axle-boxes must have ⅛ in. side play, and the center axle-box ¼ in. side play on each side of the guides, as shown in drawing.

SPRINGS.

Tender springs to be same quality, workmanship and manufacture as specified for the engine springs. Each spring to consist of 16 plates, one plate ½ in. thick and 15 plates $\frac{7}{16}$ in. thick to a span of 4 ft., each spring to be provided with hangers at the ends and buckles in the center, as shown. Each spring to be tested with a weight of 8 tons, and must resume its original form after testing.

WHEEL-CENTERS.

The wheel-centers to be of good sound cast steel of approved make, quality, and manufacture, and tests same as specified for engine. Each wheel-center to be turned to a diameter of 3 ft. 3¾ in.; the rims are to be 4⅞ in. broad, 2⅝ in. thick at center, to have 10 spokes 2⅛ in. thick at the boss and 4 in. deep; at the rims 1¾ in. thick and 3¼ in. deep. The bosses are to be bored out parallel to a diameter of 6¾ in., and are to be 11¾ in. diameter. All the centers must be bored and turned strictly to template, so that they shall be exactly alike, and each wheel-center must be forced on the axle by a hydraulic pressure of not less than 70 tons. The wheel centers are to be fixed to the axles without keys.

TIRES.

The tires to be 3 ft. 9¾ in. diameter on tread, and in every other respect to be same as the engine tires, both as regards section, quality of material, and workmanship, and to be manufactured by Vickers & Company. The same tests to be applied as for the engine tires.

AXLES.

Each axle must be made of the very best cast steel, quality and tests as specified for the engine axles, and to be manufactured by Vickers & Company. Centers of journals to be 6 ft. 6 in., diameter, 5¼ in., and length, 9 in.; other dimensions as shown in drawings.

STEAM-BRAKE.

A steam and hand-brake combined is to be fixed on tender, as shown; the cylinder, 10 in. diameter, is to be provided with means of lubrication; the brake-screw, which is to be left-handed, is to work in a cast-iron column bolted to the foot-plate at the front end of the tender, and the front pulling rod is to be provided with adjustment as shown. Each wheel is to have one cast iron brake-block applied to it. The brake-gear is to be made of the very best hammered scrap iron, all the pins and working parts being of wrought iron case-hardened, all pins to be to drawing and to have brass bushes when shown. The steam is to be led from the engine to the cylinder with a connection, as shown.

The brake material, which must be obtained from the Vacuum Brake Company, 32 Queen Victoria Street, E. C., for each tender, will consist of one main air-pipe with the necessary T-pieces, elbows and clips, one of Clayton's hose and couplings for the front of tender, one of Clayton's hose and couplings for back of tender, one end pipe with cast-iron bend, one dummy, one dirt recipient. The brake cylinder, piston and rod complete are to be supplied by the contractor. The brake-gear generally to be as shown in drawing.

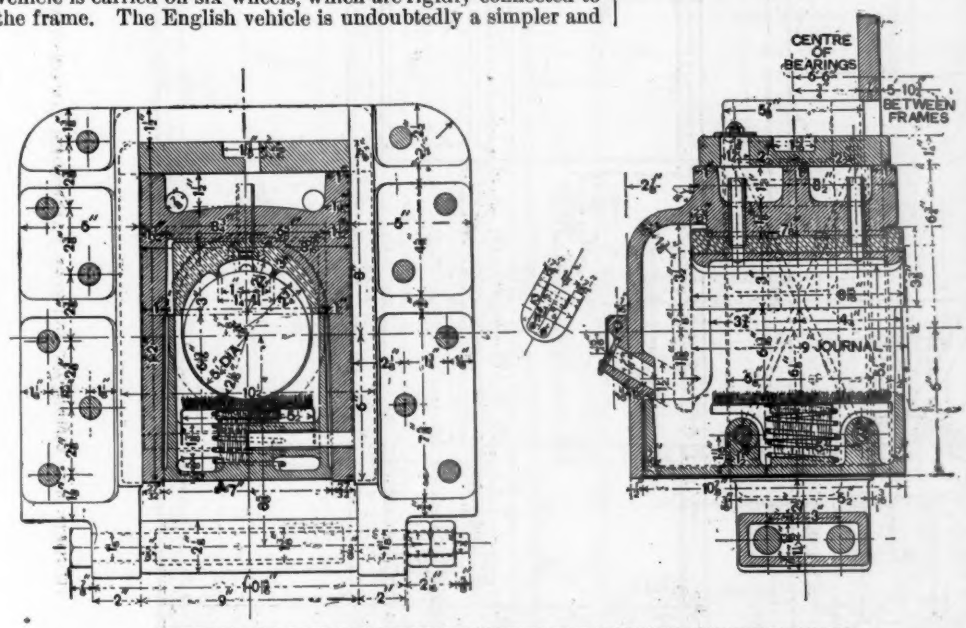
In the construction of these tenders it will be seen that there is quite a radical difference, which is characteristic of the practice here and in Europe, the American tender being supported on two four-wheeled trucks, while the English vehicle is carried on six wheels, which are rigidly connected to the frame. The English vehicle is undoubtedly a simpler and cheaper structure than the American tender. To the objection that the weight must be carried on six wheels and journals instead of eight, as in the American tender, it may be said that the English wheels are 45¾ in. diameter and the journals 5½ × 9 in. long, while the American wheels are only 36 in. and the journals 4¼ × 8 in. The carrying capacity of the six English wheels and journals is therefore probably quite as great as that of the eight under the American tender. There are fewer of them, and consequently their first cost and expense of maintenance must be less, and besides there are no truck frames, which add materially to the complication and cost of the American vehicle.

It will, no doubt, be said that the rigid wheel-base, which is 13 ft. long, of the English tender will not adapt itself to short curves as well as the flexible American trucks. To this it may be said that the relation of wheel-base to curvature is one of degree only. With the ordinary curves in use no one now objects to the six-wheeled trucks, with 10 ft. of rigid wheel-base which are used under heavy cars. Wheel-bases of over 13 ft. are in constant use under 10-wheeled, mogul and consolidation engines, and are not a source of any trouble. For the rigid wheel-base it may also be said that it is safer in case a tender gets off the track than two trucks would be. Almost anything is safe while on the track; the danger begins when it gets off.

It is, therefore, believed that very much can be said in favor of the European frame of six-wheeled tender in preference to ours with two trucks and eight wheels. When vehicles of greater length than a tender are used, then the double-truck system has very great advantages over a rigid wheel-base. This is the case with long locomotives and cars, and in this direction European practice is conforming more and more to ours. With reference to tenders, however, the same reasons do not apply, and it is believed that in this country we have entertained an unreasonable prejudice against a practice and form of construction which is simpler and cheaper than ours, and less costly to maintain and not so liable to get out of order.

When we come to the tender frame, however, the English practice does not commend itself so highly. The modern shapes of angle and channel-bars, etc., or the Fox pressed steel would seem to afford means of constructing a tender frame for a rigid wheel-base, which would in many ways be preferable to the plate frames which Mr. Adams, in company with nearly all other locomotive superintendents in England, are using. It is said that the experience on the Pennsylvania Railroad with the six-wheeled tender, which was sent over with the Webb compound locomotive, has been in every way satisfactory. It is certainly good policy, when we find that any other practice than our own is better than what we have been doing, to adopt it, and it is believed that if American locomotive superintendents would adopt the European form of running-gear for tenders, it would be an advantage to the companies by whom they are employed.

In one respect, however, the English practice in tender construction seems to be inferior to ours. We refer to the axle-boxes. By referring to the engravings of these parts it will be seen that the journal-bearing *B* bears against a key *A* on top of it. This key is held in its place in the box by lugs *D*, and in turn the flange *C* holds the bearing *B* in place. The box has a cover or lid *E*, which gives access to the journal-bearing and key, and also to the packing which is supplied below the axle to lubricate it. In order to remove or insert a journal-bearing, all that need be done is to raise up the tender so that the key *A* will clear the lugs *D*, and it can then be drawn out through the opening, which is closed by the lid *E*. When it has been taken out the bearing *B* may be raised up so as to clear the collar on the axle, and can then also be removed and a new one put in its place. This can all be done in less time than it has taken to write the description of the process, by merely putting a screw or hydraulic "jack," similar to one illustrated on another page, below the box, and raising it up about half an inch. All the packing in the box used for lubrication may be removed without raising up the box and by merely opening the cover *E*. It will also be noticed that the whole box is made in one piece, so that there can be no leakage from it, excepting around the axle or where the dust-guard is placed.

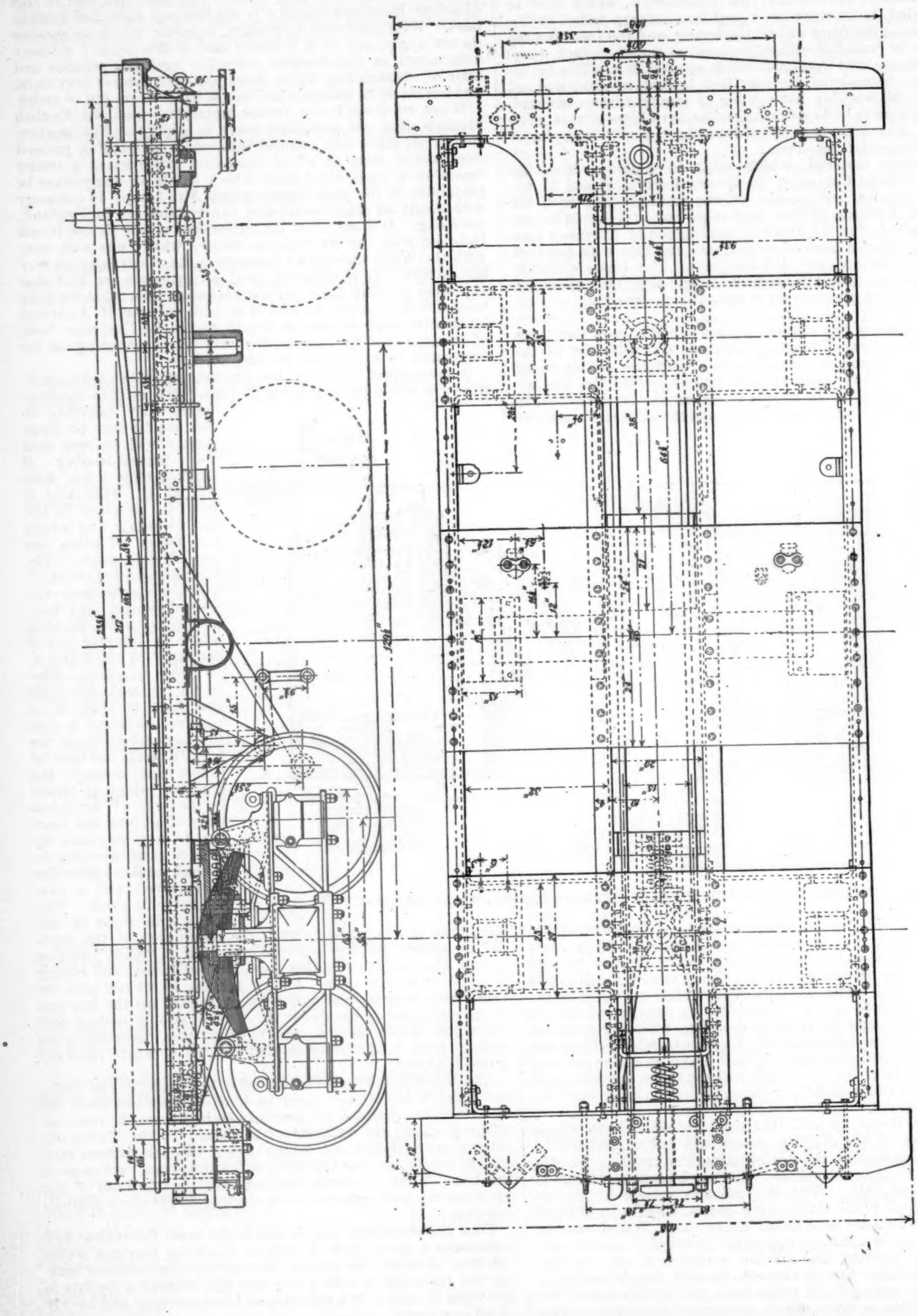


TENDER OIL-BOX FOR ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

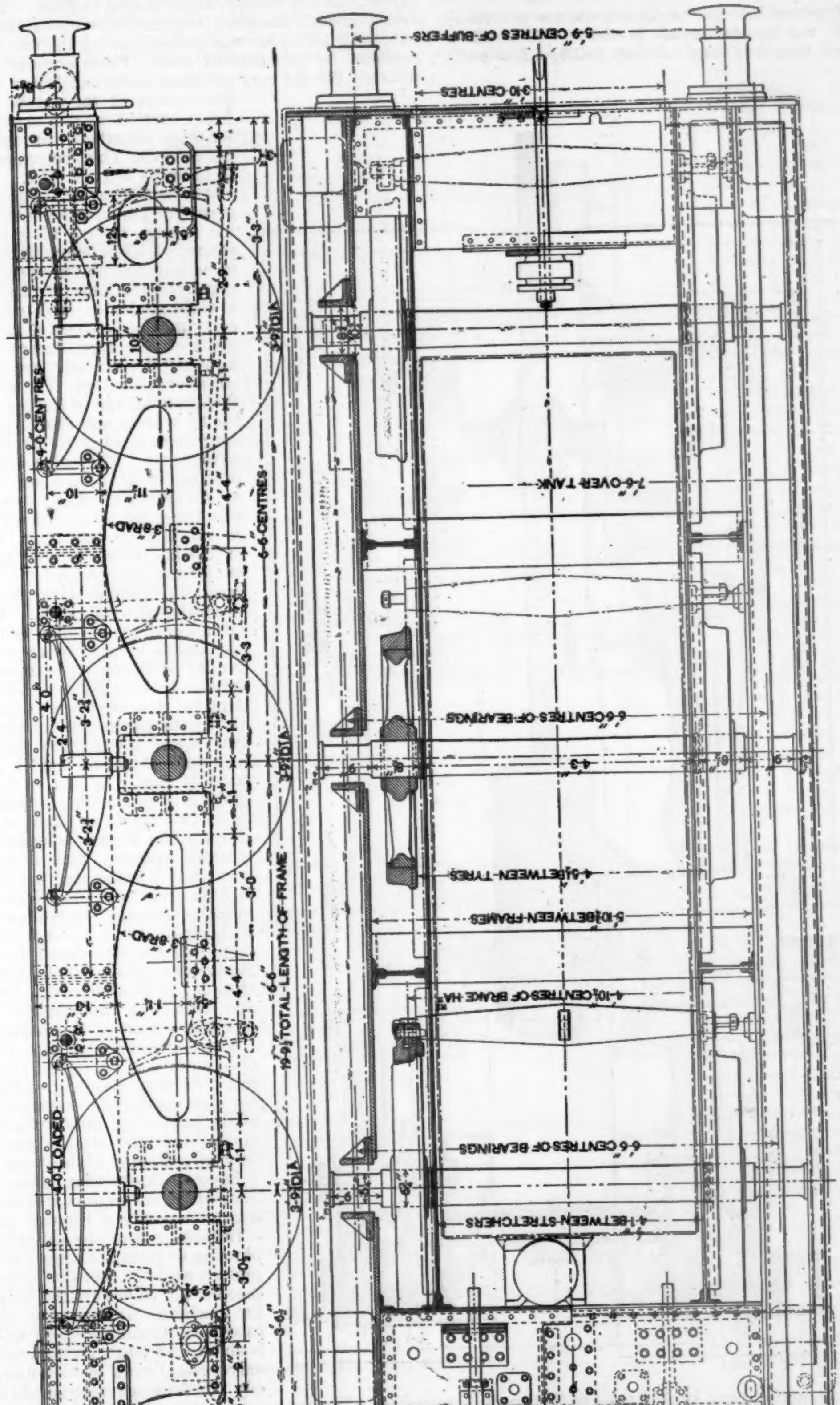
The English box and the oil-cellar are made in two parts, and these it would seem must be liable to leak and allow the oil to escape. Besides, the journal-bearing cannot be removed without taking the axle out of the box. To do this the oil-cellar must be taken out, which cannot be done without raising the tender, so that the jaws or "horn-plates" are clear of the box. In other words, the box must be taken out of the jaws and the axle removed from the box to get out a journal-bearing.

That the American box is much the most convenient and must save a great deal of time in renewing bearings seems obvious. As every one knows, the renewal of a worn-out bearing and replacing it with a new one and repacking the box is the work of only a few minutes, and is done daily and hourly on all our roads.

Of the other details of the tender nothing more need be said. The drawings will well repay study to any one interested in the practice in the two countries.



TENDER FOR AMERICAN EXPRESS PASSENGER LOCOMOTIVE.



TENDER FOR ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

BLOWING ENGINES.*

BY JULIAN KENNEDY, PITTSBURGH, PA.

THE different types of blowing engines in use are so numerous that it would not be practicable to consider them all in this paper. I shall therefore only take up briefly a few well-known types.

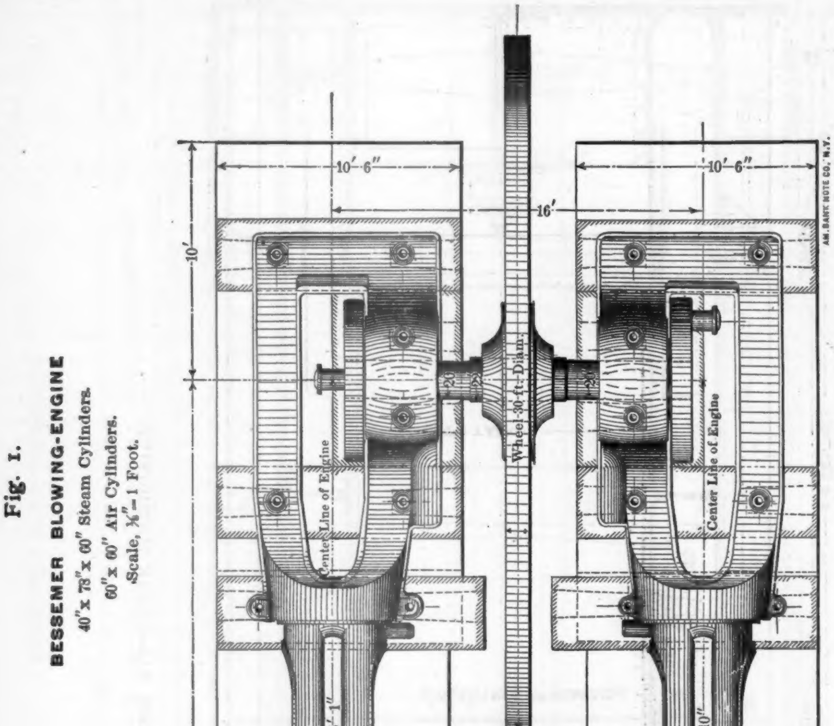


Fig. 1.
BESSEMER BLOWING-ENGINE
40"x 73"x 60" Steam Cylinders.
60"x 60" Air Cylinders.
Scale, 1/8"=1 Foot.

The style of blowing engine most largely used in this country is the vertical engine with air cylinder above, cross-head between steam and air cylinders, and two fly-wheels, each having a wrist-pin in its hub or in one arm. This kind of engine can be built cheaply, takes up little room, and is very accessible. Its disadvantages are that the cross-head is liable to break, and that putting the wrist-pins in the wheels tends to set up vibrations in them. It is likely that on the whole this type of engine will continue to be built quite extensively.

The same general arrangement has also been used to some extent, but not widely, in horizontal engines. The Bethlehem Iron Company has some very fine blowing engines of this type, except that they are compound, having the one steam-cylinder replaced by two side by side. These engines are noticeable not only for the very excellent workmanship on them, but also on account of the weight of the pistons being carried by steam pressure applied to these chambers through the hollow piston-rods. This arrangement, I believe, has always worked well.

Another type of engine which has given good satisfaction is the vertical double engine, having air-cylinders above, steam-cylinders below them, and cranks at bottom, the engines being coupled to cranks on the ends of the shaft, placed at right angles to each other, the shaft carrying the fly-wheel at its center. Engines of this type, except that they are arranged horizontally, are also used to a considerable extent. These engines avoid the disadvantage of having wrist-pins in the fly-wheels, and also dispense with the long cross-head, with its attendant disadvantages. They give a very uniform pressure of blast, and are very convenient for starting. The vertical engines of this type, as compared with the horizontal, take up less room, and the wear on cylinders, due to carrying the weight of pistons, is avoided. On the other hand, the machine is very high and there is considerable vibration. The horizontal machine avoids this, is very accessible, and is cheaper to construct. With proper attention there seems to be no serious trouble with wearing of cylinders, so that wherever ground room is ample the horizontal double-coupled engine seems to be very suitable. The principal objection urged against this style of engine is that in the event of a break a large machine is disabled, whereas, if two single engines are used, one can keep the works going while the other is being repaired. This is doubtless correct; but I think that too much weight is often given to this consideration. With machines strongly proportioned and carefully built there should be very few stops; on the other hand, in the case of Bessemer engines, which are starting and stopping at short intervals, the fact that one attendant can handle the double machine is worthy of consideration.

The double-coupled type of engine is also particularly adapted to compounding. As most blowing engines run under a comparatively constant load, and as the increasing use of water-tube boilers in iron and steel works renders it easy to maintain high steam pressures, I have no doubt that before long compound blowing engines will be adopted in a large majority of the new plants built.

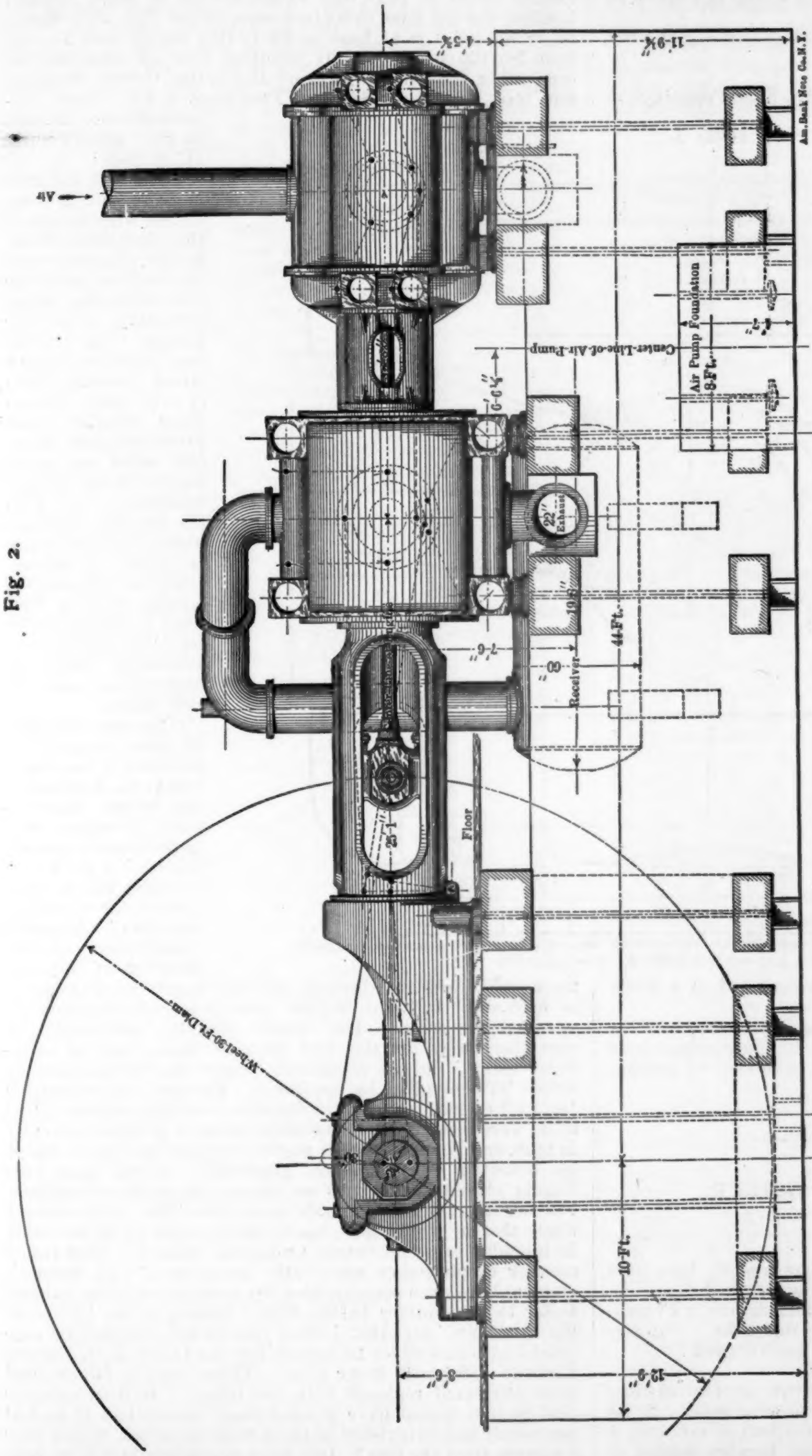
In looking over the different kinds of blowing engines, we cannot fail to be impressed with the fact that in nearly every case the air valves are the weak point in the machine. In the great majority of cases the maximum speed of the engine is about half what it could be if the air valves could work fast enough. To remedy this fault several plans have been resorted to. In some cases fairly good results have been obtained by making the valves very light, giving them but little lift and arranging them so that they shall seat by gravity. In some cases valves of this kind are so constructed that the air, in entering the cylinder, is compelled to pass through a large number of very small openings. This is a very objectionable arrangement, not only on account of the increased amount of friction, but because the air, in passing over the metal grids in thin streams, will absorb quite a considerable amount of

* Paper read at Chicago meeting of the American Institute of Mining Engineers.

heat from the heads, which, in the case of engines working against high blast pressures, are made very hot by the heat of compression.

This heating of the incoming air expands it and proportionally reduces the weight of air entering the cylinder at each stroke. I have observed this in the case of an engine which was so constructed as to cause the air to travel about 3 in. over the hot metal in thin films about $\frac{3}{16}$ in. thick. Alongside of it was another engine of the same size and make, except that valves were used which allowed the air to pass over about 1 in. of metal, the openings being of such size that each stream of air was 2 in. in thickness. Careful and repeated tests of these engines, when both were in good order, showed that while the indicator diagrams were practically the same, the one with the large valves would burn about 10 per cent. more coke in the furnace—a result which could only be explained on the supposition that, in the case of the engine with small air openings, the incoming air, in passing through the small and tortuous passages in the heads, was heated about 25° C. more than in the case of the other engine. It is plain, therefore, that a blowing engine should have air valves which will not only give ample area of inlet passage, but give this in a small number of good-sized openings.

Fig. 2.



ELEVATION OF BESSEMER BLOWING-ENGINE SHOWN IN PLAN IN FIG. 1.

Figs. 1 and 2 are the plan and elevation, and fig. 3 is the diagram of air valves and valve gear of a compound horizontal blowing engine now being constructed by the well-known builders, the E. P. Allis Company, for the Ohio Steel Company. The engine is a Reynolds-Corliss cross-compound; steam cylinders, 40 in. × 78 in.; air cylinders, 60 in.; stroke, 60 in., with re-heater in intermediate receiver, and is provided with an independent condenser. In general design this engine, as will be seen at a glance, is very similar to the large quadruple-expansion engine by the same builders to be seen at the Exposition. The air cylinders are so arranged as to draw the air through pipes which project above the roof of the building and to discharge it below the cylinders.

The inlet valve is a plain rotary valve held to its seat by the blast pressure, which is admitted to the back of the valve by a port from the discharge chamber, and is driven from a wrist-plate. The outlet valve, as will be noticed, is a triple-ported valve, which is closed at the proper time by the wrist-plate.

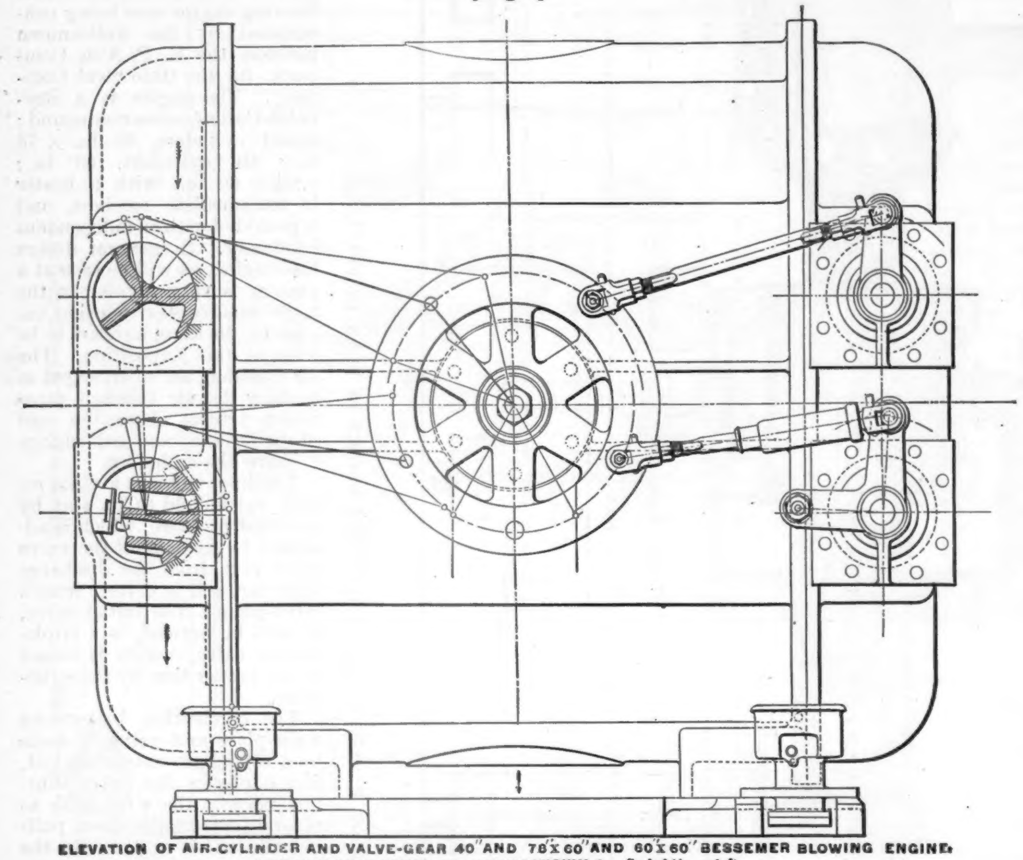
The connection between wrist-plate and valve is made by a telescopic extensible rod, which pushes the valve shut, but permits the wrist-plate to reverse its motion without pulling the valve open. To the valve lever is attached a vacuum pot which tends to pull the valve open. When the valve has been closed it is gripped by the receiver pressure acting on the back, holding it against the seat, and remains stationary during the return stroke of the piston and also while the piston advances toward it again, until it has compressed the air in the cylinder to nearly the same pressure as in the receiver, at which time the pressure on the back of the valve becomes so nearly balanced that the vacuum pot can move the valve, which is then quickly thrown open. The telescopic connecting-rod is so constructed that a small dash pot is formed at the bottom of the tube to avoid shock should the plunger strike the bottom while the valve is opening or when the closing motion begins. It will be observed that no trip or releasing gear of any kind is used with these valves, the holding and releasing being done by friction, controlled in the simplest possible manner by the air pressure in receiver and cylinder. The outlet valves are also held against their seats by long flat springs bearing in the center on the back of the valve and at ends on blocks set in pockets at end of the valve. It will be

seen from the drawings that these blocks have a clearance of ½ in. at the bottom, so that if for any cause the valve should be prevented from opening at the proper time it will be only forced back from the seat, the opening of ½ in. being sufficient to allow the engine to run at full speed with wrist-plate and vacuum-pot disconnected from outlet valves. This valve gear is extremely simple, and practical tests have shown it to work admirably. This engine is intended to run at a speed of 60 turns per minute if necessary.

In conclusion, the tendency in designing blowing engines seems to be in the following directions:

1. Compounding.
2. Obtaining valve gear which will give liberal openings at both inlet and outlet, and which can be operated at a fairly rapid speed.

[Fig. 3.



ELEVATION OF AIR-CYLINDER AND VALVE-GEAR 40" AND 78" x 60" AND 60" x 60" BESSEMER BLOWING ENGINE FOR THE OHIO STEEL CO., YOUNGSTOWN, O. Scale ⅜ in. = 1 ft.

The latter advantage can probably be best secured by the use of metal valves operated as far as possible positively, which will also do away with the vexation due to the use of leather, gum, and other short-lived materials.

THE MULTITUBULAR BOILER.

In commenting on an article which has recently been published in an American paper, in which the credit of the invention of the tubular boiler is claimed for Marc Seguin, a Frenchman, a correspondent of the *English Mechanic*, asks, "Can any of your readers say where the true facts are recorded?"

This correspondent then says further:

"It should be borne in mind that there are two distinct ideas involved: 1. The invention of the tubular boiler. 2. Its adaptation to the locomotive engine. Regarding the first, it seems preposterous to ascribe it to Seguin, because Smiles, in his 'Lives of the Engineers,' states that as early as 1780 (before Seguin was born), Matthew Boulton employed in the boiler of the Wheal Busy engine in Cornwall longitudinal copper tubes through which the fire passed, and on August 27, 1784, James Watt, in a letter addressed to Boulton on the subject of a locomotive he was planning, says: 'Perhaps some means may be hit upon to make the boiler cylindrical, with a number of tubes passing through.' It follows that even if Marc Seguin had constructed a locomotive with tubular boiler before the date of the *Rocket* in 1829, he would only have adapted to the locomotive that which had long been in use in stationary boilers. But I can find no evidence that he did construct such a locomotive, while there is strong presumptive evidence that he did not. *He took out a patent* for a tubular boiler in 1828; but James Neville, of Shad Thames, London, did the same thing two years earlier (No. 5344, March 14, 1826), and it is at least as likely that Seguin took his idea from Neville (who expressly mentions that his tubes may be used either vertically or horizontally) as that George Stephenson took his from Seguin. Perdonnet, in his 'Traité Elémentaire des Chemins de Fer,' says (Volume II., p. 360):

"'In 1825 and 1826 Marc Seguin, in association with the son of the illustrious Montgolfier, together with his brothers, made the first attempts at steam navigation upon the Rhone. This is the first occasion upon which a tubular boiler was used, but another occasion soon presented itself where this boiler was to be used with still greater advantage. In 1825 the Seguin Brothers obtained a concession to build a railroad from St. Etienne to Lyons, and in 1827 used a tubular boiler on a locomotive. In February, 1828, he took out a patent for this boiler.'

"On the strength of these statements, evidently communicated to Perdonnet, that writer dubs Seguin 'Inventeur de la Locomotive a Grande Vitesse,' and even (Volume II., p. 361) 'Inventeur de la Locomotive.' A careful examination of the wording of this extract will, however, disclose such ambiguity as to make it at least doubtful that Seguin ever practically applied his so-called invention. The words (literally translated), 'it was then that for the first time he made use of a tubular boiler,' do not necessarily imply that he invented the boiler, but only that he applied it. Further, the expression 'en 1825 et 1826' leaves it in doubt as to which year the actual trials were made. Now, Neville's patent was taken out early in 1826, and he mentions the marine boiler as the type to which his invention is particularly applicable. In the same year Seguin visited England to see George Stephenson's engines. Further, Seguin's patent only bears date 1828. It is scarcely likely that he would have made public trials of an invention he intended to patent before protecting himself. Now comes another circumstance apparently inconsistent with Seguin's claim to have even contemplated the application of the tubular boiler to locomotives before 1829. Smiles, in his 'Lives of the Engineers,' says that in that year George Stephenson supplied two locomotives to Seguin for the Lyons & St. Etienne Railway *fitted with water tubes*. These were a failure, and were afterward replaced with fire tubes. Is it conceivable that Seguin would have ordered such locomotives if he had previously had experience of those with fire tubes, which were a success from the first? But there is another still more puzzling fact. In the article 'St. Etienne,' *Encyclopædia Britannica*, it says the Lyons & St. Etienne Railway was opened *in* 1831.

"I leave out of consideration altogether the clearly-established fact that George Stephenson avowedly borrowed his idea of the tubes from Henry Booth, who said he had never heard of Neville's patent, much less Seguin's."

THE STEERING OF BALLOONS.*

By Rudolphe Soreau.

III.—EXPERIMENTS AT CHALAIS-MEUDON.

Balloon Ascensions of La France.—Between the two ascensions of the Messrs. Tissandier there were the well-known experiments of Renard and Krebs. On August 9, 1884, according to the report of Herve-Mangon, the balloon *La France*, having on board its two inventors, started from the military post of Chalais-Meudon in calm weather, and made evolutions with the greatest ease and then returned to Chalais, where it descended upon the same lawn from which it started. In spite of the groves, fig. 10, with which it was surrounded, it traversed about 4¾ miles in 20 minutes. "As soon as we had reached the top of the wooded plateaus which surround the valleys of Chalais," says Commandant Renard, "we started the screw, and had the satisfaction of seeing the balloon immediately obey it, and readily follow every turn of the rudder. We felt that we were absolutely masters of our own movements, and that we could traverse the atmosphere in any direction as easily as a steam launch could make its evolutions on a calm lake. After having accomplished our purpose we turned our head toward the point of departure, and we soon saw it approaching us. The walls of the park of Chalais were passed anew, and our landing appeared at our feet about 1,000 ft. below the car. The screw was then slowed down and a pull at the safety-valve started the descent, during which, by means of the propeller and rudder, the balloon was maintained directly over the point where our assistants awaited us. Everything occurred according to our plan, and the car was soon resting quietly upon the lawn from which we had started."

This experiment was widely commented upon and provoked a great enthusiasm. It was, nevertheless, merely a trial ascension, in which the aeronauts had not dared to employ the whole of their motive power, and had hastened back to the starting-point, desirous as they were of giving themselves a practical demonstration, which they had prepared for later. The later ascensions were made with a longer run and under atmospheric conditions which were less favorable.

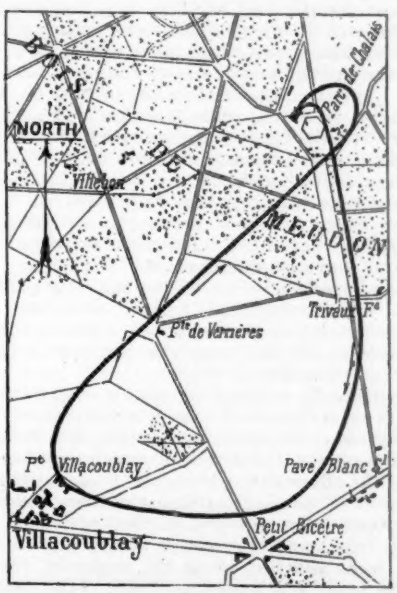


Fig. 10.

The second took place on September 12, in a wind of 20 ft. velocity, against which the balloon struggled without being blown back. It moved against the current, with the whole battery in action, but the engine turned with such great rapidity and heated to such a degree as to oblige them to stop the current. At the time when Commandant Renard was manipulating the commutator the ring broke, and the balloon, deprived of its machine, was carried to Velizy, where a landing was made without any other accident. This want of success, due to an accident to the machine, which was without importance, caused the brilliant demonstration of August 9 to be forgotten, and turned public opinion against it in a most unreasonable way. It was therefore necessary to do away with this bad impression, and a new ring was made by Gramme. On November 8, 1884, the balloon ascended with Messrs. Renard and Krebs, and rose in fine weather and turned toward the Bois de Bologne, fig. 11. It went until Billancourt lay directly beneath it, and was then taken back to Chalais with the greatest of ease. Under the action of the entire battery they attained an average speed of 20 ft. 8 in. per second. The route is represented by a full line. In the afternoon the aeronauts made a new start, and contented themselves, on account of the gale which was blowing, with evolutions around the park without losing sight of it. The route is represented by a broken line. The destruction of a portion of the winding wire did not prevent the balloon from reaching the starting-point, but the average speed dropped to 13 ft. 1.5 in.

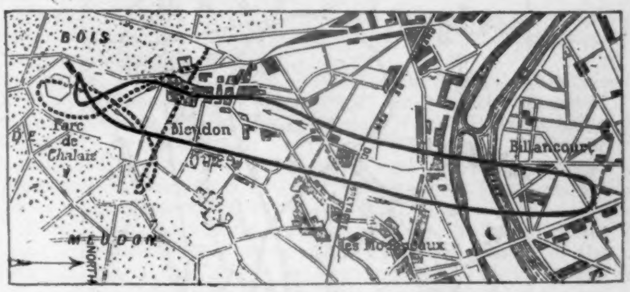


Fig. 11.

To avoid other mishaps Commandant Renard obtained the assistance of Gramme, who constructed a motor having the same weight as the old one, but stronger and a little more powerful; this last circumstance, and the lightening of certain parts permitted them to take a third aeronaut with them and to obtain measurements of their speed. These experiments were made in August of 1885. I content myself here in adding that they were made by Messrs. Charles and Paul Renard, accompanied by Dute-Poitevin, a civil aeronaut attached to the Military Establishment of Chalais. The last ascension, that of September 23, 1885, was made in the presence of the Minister of War, and was a long run, fig. 12. The balloon started against the wind and went to Paris, where it described an elegant curve, the irregularities of which proved in a striking manner the power of the motor, and the certainty with which the balloon could be manipulated. After having crossed the fortifications it returned with the wind behind it to Chalais, which it reached in less than one-quarter of an hour. In this ascension the average speed was greater, or 21 ft. per second.

The following table gives a summary of the seven ascensions of the balloon *La France*. We see that it came back five times out of seven to the point of departure.

Dates.	Number of turns of the Screw per Min.	Average Speed of the Balloon.	Remarks.
August 9, 1884.	42	15.75 ft.	Balloon came back to Chalais.
September 12, 1884.	50	18.7 "	Accident to the machine, descended at Velizy.
November 8, 1884.	55	20.67 "	Balloon came back to Chalais.
November 8, 1884.	35	13.23 "	Balloon came back to Chalais.
August 25, 1885.	55	20.67 "	Wind with a speed of about 22.96 ft.; descent was made at Villacoublay.
September 22, 1885.	55	20.67 "	Balloon came back to Chalais.
September 23, 1885.	57	21.33 "	Balloon came back to Chalais.

Since that time Commandant Renard has made no other ascensions. It was sufficient for him to demonstrate to carefully investigating men that the steering of balloons is not Eutopian, and can be accomplished in a utilitarian way. After these few months of glory Chalais went back into a calm, and, as we have said, it wishes to remain so, the experiments announced for the next spring having been made without any particular publicity. While appreciating the motives for this discretion, I regret for my own part that it has been so complete, and I declare here that it should permit all the explanations which can be given to an enlightened public that do not actually constitute a truly interesting secret of national defense.

* *Mémoires de la Société des Ingénieurs Civils.*

We see now how Messrs. Renard and Krebs have obtained such results. "We have been guided in our work," they say in a note to the Academy of science, "by the study and work of Mr. Dupuy de Lome, in regard to the construction of his balloon in the years of 1870 and 1872, and furthermore, we have undertaken to fulfil the following conditions in addition to what he has done; stability of route was obtained by the form of the balloon and the arrangement of the rudder. Diminution of resistance to progress by the choice of dimensions; the centers of traction and resistance were brought together in order to diminish the movement which tends to disturb the vertical stability. Finally, the speed was obtained which was capable of resisting the winds which prevail for about three-quarters of the time in our country." I shall show as rapidly as possible the means which were employed to realize these conditions.

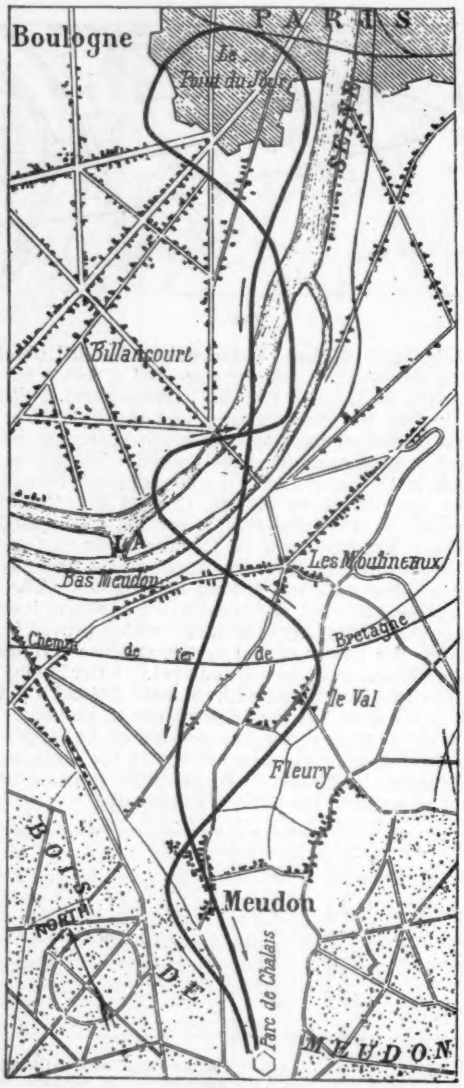


FIG. 12.

Lightness of Motor.—The motor of 1884 was a Gramme machine which Commandant Krebs knew combined a lightness hitherto unknown; it had a power of about 8½ H.P., and only weighed 220.5 lbs. The motor which it replaced, and which was designed with the assistance of Gramme, gave 9 H.P. with the same weight.

The electric generator was a battery designed as a result of the researches of Commandant Renard. The hydraulic reservoir containing five times as much liquid as in the batteries of bi-chromate was attached to the battery, and provided with a switch which permitted them to obtain either a strong current of short duration or a weak current of long duration. Experience has shown that it was advantageous to place these switches so that about 1¼ volts below the maximum are obtainable. The great total energy of the Renard battery is due principally to the substitution of chromic acid for the bi-chromate, whose alkaline base absorbs, in the reaction, a portion of the exciting liquid. Its capacity reaches its maximum when the weight of the chromic acid is equal to five-sixths that of the hydrogen acids. Then 55 watts per square decimeter of zinc per hour is obtained. The rate of current is obtained by the partial or total substitution of hydrochloric acid for sulphuric acid in the bi-chromate batteries; the total energy of the mixture does not change, but the energy per second increases with the proportion of hydrochloric acid, and can be quintupled. Finally, Commandant Renard has made a most careful study of the influence of geometrical forms and the relations of the position of the two electrodes

Generally it is superfluous to insist upon the merit of an apparatus which has been discovered, that increases by one-half the capacity and quintuples the power of the best batteries which have been known up to the present time. It is to the Renard battery that science owes the magnificent experiments which I have presented to you, and it may readily be said of this battery that it is the soul of the new dirigible balloon. I have shown in fig. 13 a group of 12 elements connected at the top in sixes; this group weighs 22.05 lbs., and it needs four of them to deliver 1 H.P to the shaft. A non-amalgamated zinc pencil of very small diameter is surrounded by a positive polar piece formed by a cylinder of platinum-plated silver of .004 in. thick. The whole is plunged into a glass jar, where chromic acid dissolved in the exciting liquid is found.

The motor drives a two-armed screw 23 ft. in diameter on a hollow shaft, the length of which is about 49 ft. It is held in oscillating bearings, which in turn are held in place by tightening screws This shaft while running assumes a curious bending motion, but not such as to produce any abnormal resistance.

Resistance to Advancement.—Messrs. Renard and Krebs studied very carefully the means of diminishing the means of resistance to advancement. The elongation of their balloon, the length of which was 165 ft. 4.3 in., with a volume of 65,000 cub. ft., fig. 14, was almost equal to the elongation of the second balloon of Giffard, but was made so that it did not compromise the safety of the aeronauts.

The main junction was placed about one-quarter of its length back from the front end. The meridian was composed of two parabolic arcs having for their axis of intersection the main junction with the meridian plane. This unsymmetrical form adopted for the keel of ships is equally applicable and desirable for that of dirigible balloons; furthermore, nature has also given this same form to birds, as well as to fishes. To determine the approximate ratio of the prow to the poop, the officers at Chalais constructed solids of ebonite of the same length, but in which the main junction had a different position. They let them fall into the water with the same velocity, and chose as a model for the dirigible balloon the one which in its descent moved without any sway. It is evident that this means of research was a very rough one.

As in the Dupuy de Lome balloon, an air balloon of calculated dimensions permitted them to be certain of an invariability of form, and a housing replaced the netting. Up to that time they had made housing of the same material as that of the balloon, which compelled them to strengthen it by bands placed transversely, so that it could work in this direction. Commandant Renard used transverse bands, and thus obtained a very marked reduction of weight.

The suspension by a triangular system suggested by Dupuy de Lome was not sufficient with the elongation chosen. Finally, in order to avoid overturning, the officers of Chalais designed another arrangement, the details of which they have not made known, but the efficacy of which has been proven by experience. Instead of passing through the same nodal point, the balancing ropes were grouped in two systems; they were attached to two transverse pieces which started from these bands and were attached about the center of the car. The length of the latter was limited to 108 ft. 3 in., the suspension cords, which held it almost vertically to the bolster, were light and short; they were drawn almost exactly in two planes parallel to the axis. This arrangement singularly diminished the resistance due to the cordage, which was only equal to about one-half of the total resistance with the system laid down by Dupuy de Lome; furthermore, the center of traction and the center of resistance were brought nearer together, and consequently the disturbing moment of traction was diminished; but it diminished the stability of the system at the same time, since its center of gravity approached that of the mass of air displaced.

The car, formed of four bamboos fastened together by twisted wire stays, was covered with silk, which was drawn perfectly tight, giving a far less resistance than would have been the case had basket sides been used. It had a height of 6 ft. 7.8 in. at its center, and was not accessible throughout its

whole length. The aeronauts were at the height of windows made in the sides.

Certainty of Route.—The unsymmetrical form of the balloon by separating the center of inertia from the back evidently increased the efficacy of the rudder. The latter was made of two pieces of silk stretched very tight upon the same frame, but very slightly separated one from the other, so as to constitute two quadrangular pyramids of a very slight height joined to one another. The inventors have not given any reason why they adopted this form; for my part I think it an excellent thing, in that it seems to have had the effect of rendering the resistance of the air upon the rudder practically

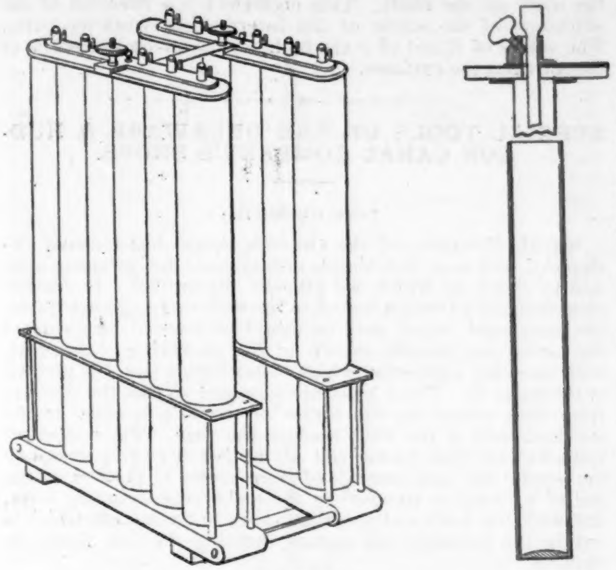


FIG. 13.

perpendicular to the frame, while with the ordinary form this resistance produced, especially at high speeds, a greater or less concavity, which was accentuated on that side which was farthest removed from the balloon, and which had the effect of laying down upon the axis of the dirigible the resultant of the pressure of the air upon the rudder.

On its own part the unsymmetrical form of the balloon contributed very essentially to guarantee stability of route. Let fig. 15, $X X'$, be the route followed, $A\ V$ the direction of the wind, $A\ Y$ that of a relative wind, which is the center line of the car, $A\ B$ the figurative length of the speed proper. In constructing the parallelogram of speeds, we find how it results for the wind with a speed $A\ C$. Suppose that suddenly this speed changes and becomes $A\ C_1$. For a very short instant which follows this variation, by virtue of the speed acquired, the balloon continues to follow the route X. On the other hand, the proper speed preserves the same magnitude, since the screw continues to make the same number of turns; if, then, we trace from the starting point, C_1, a straight line $C_1\ M_1$ equal to $C\ M$, we obtain the new direction of the relative wind. Struck by this relative wind $A\ B_1$, which is no longer directed along the axis of the balloon, the balloon itself turns around the vertical of the center of inertia, so as to place itself in the direction of the wind as it was in $A\ B$. In what direction, then, will this rotation take place? The prow presents itself to the current while the poop drops away from it.

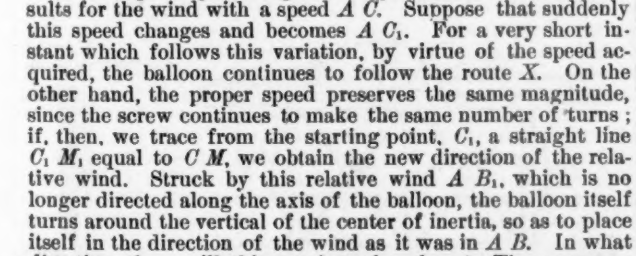


FIG. 14.

It is therefore clear that in symmetrical balloons, fig. 16, the push will tend to make it execute a turn about which increases in rapidity as the arm of the lever $I\ H$ increases. On the other hand, we can combine the dimensions of an unsymmetrical balloon, fig. 17, so that the poop, in spite of its dropping away, receives the greater part of the effort of the wind; it is necessary, therefore, that it should have a sufficient length. The pressure, then, presents itself as indicated by the figure. A turn-about, therefore, is not to be feared, and a few oscillations set the balloon quietly in its new axis in line with the relative wind.

Finally, the location of the screw at the front end facilitates the action of the dirigible against the wind; and, as has been said, this position was very judiciously chosen. If we should attempt to roll over rough ground a wheel-barrow with a flexible frame, there is no doubt but what we could pull it easier than we could push it. Is it not the same case with the balloon? The structure is of flexible material, the cordage and basket can only be moved through the air at the expense of great effort. Furthermore, the screw placed at the front end has an advantage of moving in air which has not yet been disturbed by the passage of the balloon.

So that it is not only the elongated form of the car which contributes, by being drawn out in a direction of least resistance, to increase the stability.

Progress Made and Improvements to be Developed.—From this slightly protracted analysis the result was that the officers of Chalais-Meudon had very fortunately fulfilled the delicate conditions imposed by the nature of the problem. With the exceptions that the vertical stability had not been obtained automatically, though if I have a good memory Commandant Renard had formerly examined into this matter.

Formerly, when vertical oscillations of two or three degrees were encountered, they were set down to the account of the irregularities of the form or the local currents of air in a vertical direction. I have attributed this, for my part, to the too slight distances between the balloon and the car from which there results a diminution of the couples of stability, which becomes powerless to overcome the imperceptible oscillations of the abundant movements produced by variations in the wind, vertical instability, or any other cause.

The comparison of the resistance measured in the ascensions of 1885 with those which had previously been made by Dupuy de Lome, and which were verified in their totality by the experiments of 1872, have convinced me that the many precautions taken at Chalais, to diminish the resistance to advancement, have not given all the results which could be expected. I will return further on to these conditions.

To measure the progress accomplished by Messrs. Renard and Krebs, it will be sufficient to glance at the following table, where I have brought together the principal characteristics of the balloons which we had examined:

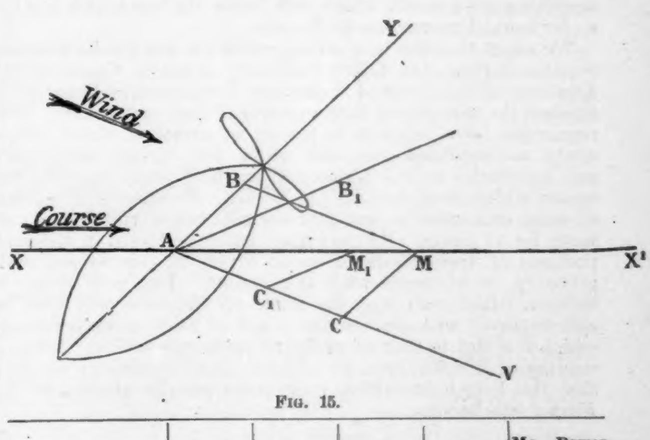


FIG. 15.

	Volume.	Elongation.	Main Union.	Horse Power on Shaft	Mo. Power per 100 sq. yds. of Principal Connection.
	Cu. ft.		Sq. yds.		
Giffard, 1852........	88.290	3.6	145.8	3 H. P.	3.18 H. P.
" 1855........	103,010	7	93.87	3 "	4.58 "
Dupuy de Lome....	127,140	2.43	172	.65 "	.46 "
Tissandier, 1884....	25,320	3.04	79.53	1.5 "	2.7 "
Renard & Krebs....	65,880	6	66.26	9 "	19.5 "

This progress will assume the same prominent characteristic when we couple it with the routes followed by *La France*, figs. 10, 11 and 12, and that which Tissandier succeeded in traversing in 1884, fig. 9. When the officers at Chalais undertook the construction of their dirigible balloon, the principal question was as follows: The motors would give 10 ft. velocity, which was insufficient, since that of the wind was

above it at least once out of five times; then they had not yet succeeded in avoiding collapsing, and making it obey the rudder so as to insure certainty of travel. In what conditions, then, did they leave the problem? The speed reached 28 ft.; the balloon obeyed with marvellous docility without turning about; it made its evolutions like a well-constructed boat upon the surfac of tranquil waters.

In this work, which will remain one of the finest examples of careful construction and investigation of our century, it is well to indicate the special part taken by each of the two fellow-workmen. The execution of the programme and the examinations which it required were made together. The study of the arrangement of the suspending sheet; the determination of the volume of the balloon; the arrangement made for insuring the longitudinal stability of the balloon; the calcu-

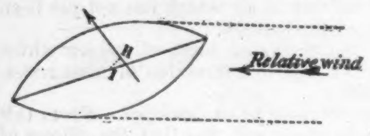


FIG. 16.

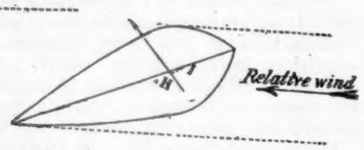


FIG. 17.

lations of the dimensions given to the pieces of the car, and, finally, the invention and construction of a new battery of an exceptional lightness and power, which constitute one of the essential parts of the system, are the personal work of Commandant Renard. The different details of the construction of the balloon, its method of attachment to the sheet, the system of construction of the screw and the rudder, an examination of the electric motor, calculated according to the new method based upon preliminary experiments, permitting them to determine all the elements of a given force, are the works of Krebs, who, thanks to especial arrangements, has succeeded in bringing about the construction of this apparatus under conditions of unexpected lightness.

What remains now, then, to make the steering of balloons really practical? It is necessary to double the speed that has as yet been obtained by increasing the volume and reducing the resistance, or raising the efficiency of the screw, which in the balloon *La France* was only passable, and especially in searching out a motor which will leave the one which has led so far toward success far in the rear.

We assert that this new arrangement has not yet been made. Separated from his fellow-workman, actually Commandant Engineer of the Corps of Pompiers, Commandant Renard has finished the task which they pursued at first in common. His researches have led him to invent an excellent motor which really accomplishes this, and which will weigh, carburetter and accessories included, one and one-half times less than the motor which was used in *La France*. Furthermore, instead of being exhausted in one and one half hours' running, it can work for 12 hours. By the improvements effected in different portions of the balloon, a speed of 36 ft. per second will probably be obtained with this motor. The new dirigible balloon, which will bear the name of *Meusnier*, will then be able to travel with an average s eed of 24.85 miles per hour, which is equal to that of ordinary passenger trains. It has a volume of 120,077 cub. ft. Under these conditions we find that the length in which it is geometrically similar to *La France* will become

$$50.4 \sqrt[3]{\frac{1.861}{3.400}} = 205 \text{ ft. } 8.6 \text{ in.};$$

but it will be 229 ft. 7.8 in. long; the elongation will exceed that of *La France*, perhaps even that of the second Giffard balloon. A housing will carry, by means of suspension and balancing cords, the car, 131 ft 2.9 in. long, which will be made of bamboo and stringers of hollowed-out pine with stays of hollow steel. The screw will be 29 ft. 6.3 in. in diameter, and will make 200 turns per minute. After General Meusnier other apparatus equally progressive over the preceding ones will be made. What I wish to examine now are the means of accomplishing this advancement.

The first quality necessary to realize it is the certainty of route, as well as quickness of manœvring. Without this quality all others will be of no effect, and the balloon will be found in the situation of a deaf mute, who feels the floods of eloquence existing within him. Such was especially the case with the Giffard balloon. I have carefully enumerated the conditions which it is necessary to fulfill, and I have said how they were realized at Chalais. The balloons conceived on the same principles will be quite amenable to the power of their motor.

Their value will then be measured by the obtainable speed. In order to obtain the speed V, it will be necessary to combine the net, the car, the propeller, and the motor, so that

$$\frac{Tr}{R} = V.$$

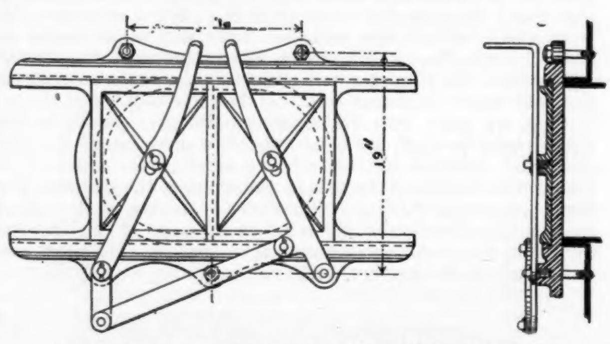
T being the power delivered to the shaft of the machine, R the resistance to advancement which corresponds to the speed V, r the coefficient of reduction between the tractive work and the work on the shaft. This coefficient is a function of the efficiency of the screw of the intermediate working parts. The values of R and of r are both dependent on the action of the air upon the surfaces.

SPECIAL TOOLS OF THE DELAWARE & HUDSON CANAL COMPANY'S SHOPS.

LINK GRINDER.

MR. H. C. SMITH, of the Oneonta shops, has recently designed a very neat and simple arrangement for grinding locomotive links, of which we give an illustration. It consists essentially of a bracket bolted to the wall carrying an adjustable cross-head, which may be raised or lowered by means of the screw and handle shown in the engraving; this cross-head carrying a pin upon which the swinging bar A is pivoted at the holes B. These holes are arranged so that the distance from their centers to the center of the link is equal to the standard radii of the links used on the road. The method of fastening the link to the end of the bar is clearly shown on the engraving, and consists of four hooks, C, pivoted on the end of a crossbar attached to the end of the swinging lever, and with the hook end so arranged as to clasp a pin which is put in the eccentric-rod centers, holding the link firmly in position.

The emery wheel which is used is, of course, smaller than the distance between the two faces of the links, and is brought in contact with one face or the other by raising or lowering the cross-head already referred to, by means of the screw and handle; thus while the link itself is raised and lowered, bringing one face or the other in contact with the emery wheel, there is no change whatever in the radius of the swinging of the link which is always true with the actual link radius. This portion of the mechanism consists merely of an arbor-carrying over-hung wheel, as shown in the side elevation, with a spring for holding it in position and preventing side thrusts, with a screw at the back end for taking up lost motion. The whole construction of the device is so simple and so clearly shown that further description is hardly necessary.

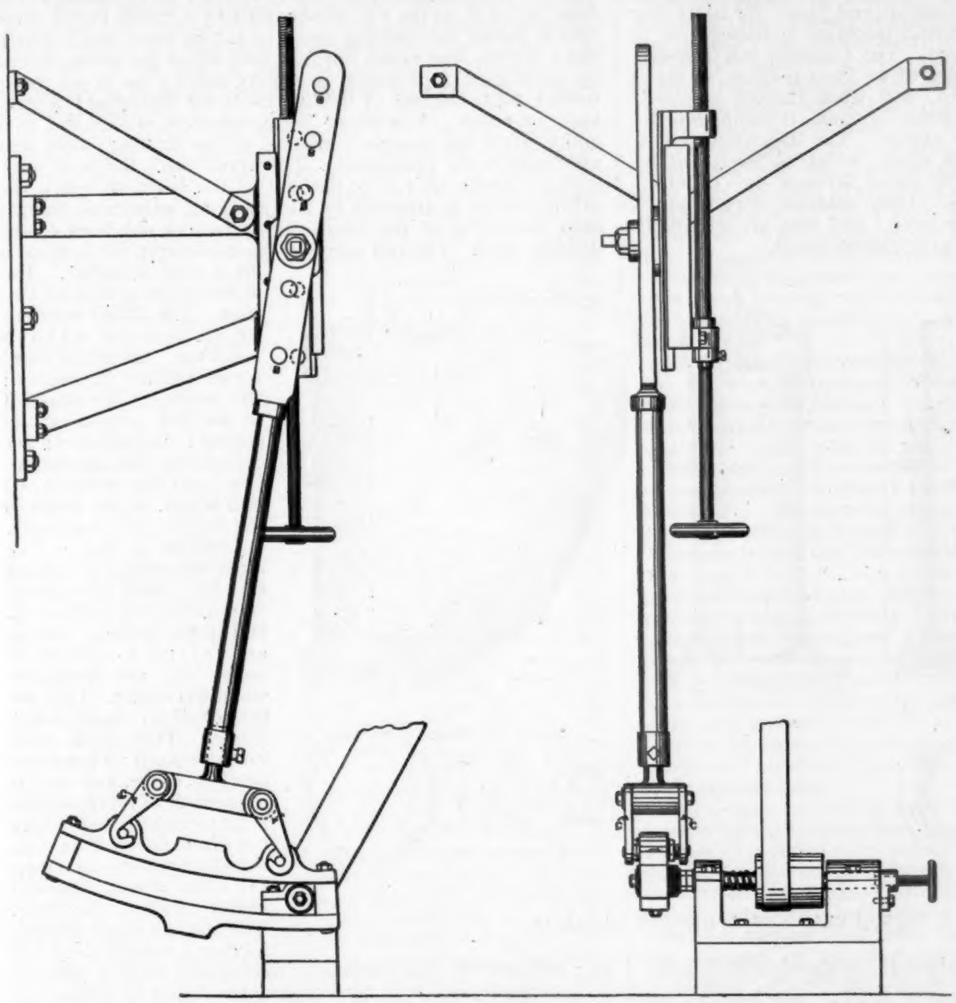


FURNACE DOOR, DELAWARE & HUDSON CANAL CO.

FURNACE DOOR.

The standard furnace door used on all of the engines of the road is shown by the accompanying engraving. It consists of a framework setting around the furnace opening into which two sliding doors are set, which are operated by levers in such a way that whether the top end of either handle is moved outward, both doors open an equal amount from the center. This enables the engineer to assist the fireman in opening his doors when it is necessary, and also provides the fireman with facilities for opening the door with a scoop instead of throwing it open with his hand. As first built, only one of these handles was carried to the top of the door, but in later constructions it has been modified in accordance with the drawing. One of the many advantages of this door is that it has

no tendency to close under the action of the blast, and where an engine is steaming too rapidly, or it is desirable to admit a current of air into the fire-box over the coal, the door can be opened to any extent and left so without danger of its being blown shut. This is, of course, very much better than opening the ordinary door and setting it on the latch, and it also has the advantage of enabling the opening to be made to any desirable extent. The chief dimensions of the door are given in the engraving, and its construction will be very readily understood. This is the same door which is used very extensively in Germany, except where they still have but one handle rising to the top of the door.



LINK GRINDING MACHINE, DELAWARE & HUDSON CANAL CO.

OIL-BOX JACK.

The hydraulic oil-box jack illustrated is a very handy little tool and of simple construction. The total height over all is 9½ in. The pump is operated by means of a toothed sector and rack, the former being given a partial rotation by a lever outside of the jack itself. The valve arrangements are shown in the vertical section. As the ram works up and down, the suction-valve and delivery-valve are operated as in an ordinary pump, but when it is desired to lower the lifting ram the lever is turned down, so that the side of the sector comes in contact with the stem of the relief-valve pressing it in and allowing the liquid to flow directly from the cylinder of the lifting ram into the reservoir in which the sector and the rack work.

The packing is of the ordinary U-shaped leather packing, and is located as shown in the engraving. Just above this there is a leakage ring, so that any liquid which escapes past the leather packing is caught by it and returned to the reservoir. A filling tube is located on one side, by means of which the waste from the reservoir can be replaced without taking off the cap. The handle, as shown on the side elevation, enables the jack to be readily carried and handled.

THE MIDDLESBROUGH SALT INDUSTRY.

Discovery at Middlesbrough.—Like so many discoveries, knowledge of the existence of the Middlesbrough salt bed came about by means of operations undertaken with quite another object. In 1859–62 Messrs. Bolckow, Vaughan & Company, having bored to a depth of 1,200 ft. on the south bank of the Tees in search of water, discovered a bed of rock salt 100 ft. thick. Shortly afterward they endeavored to sink a shaft, with a view to working the mineral as a rock salt mine. The influx of water, however, proved to be so serious that after heavy expenditure the attempt was abandoned. In 1874 Messrs. Bell Brothers sank a borehole at Clarence, on the north side of the river, and found the salt at 1,127 ft. There the matter rested until 1881, when Sir Lowthian Bell's brother, Mr. Thomas Bell, proposed a method of winning the salt by using one and the same well for sending water down to the salt bed and for pumping up the saturated solution, the fresh water going down the annular space between the larger external tube which formed the lining of the well, and the smaller central tube through which the brine was pumped up. Although Mr. Bell was not aware of the fact at the time of proposing this method, it was then already in operation in France, and after a visit to the French works Messrs. Bell sank a well of suitable size, constructed evaporating apparatus, and in 1882 began making salt. To Messrs. Bell Brothers, therefore, belongs the honor of having been the pioneers of this important industry.

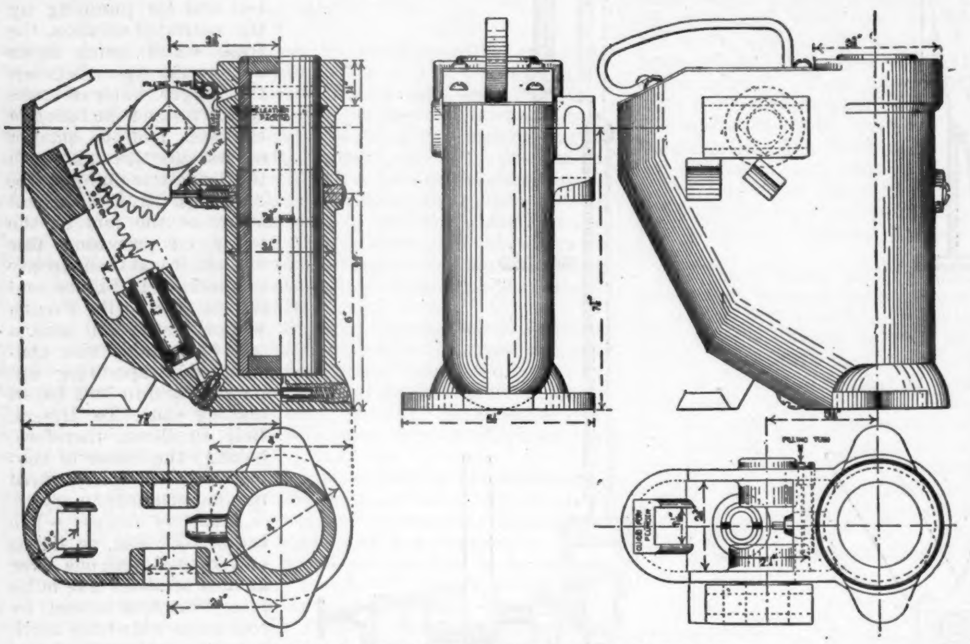
Extent of Deposit.—The bed of rock salt, so far as now proved, extends over an area of about five miles long from west to east, by four miles wide from north to south, or about 20 square miles. Each square mile is estimated to contain 100,000,000 tons of salt; and although, by any method which now appears likely to be adopted, a proportion probably not exceeding 25 per cent. of the whole can ever be brought to the surface, yet the figures are so large that the question of possible exhaustion of supply need not be taken into account. The most northerly borehole is near Greatham, where the bed of salt was found at the depth of 889 ft., and is 57 ft. thick; the most southerly is at North Ormesby, where it was found at 1,340 ft., and is 79 ft. thick; the most easterly at Lackenby, the bed being met with at 1,685 ft., and 119 ft. thick; and the most westerly at Sandfield, Haverton Hill, where the bed occurs at the depth of 797 ft., and is 80 ft. thick. The thickness of the bed varies considerably, but the average may be taken at 80 ft. to 90 ft.

Analysis.—It is difficult to give an average analysis of the bed, owing to difference in proportion of marl mixed with the salt. Samples are obtained showing as high as 98 per cent. of sodium chloride, and as low as 45 per cent.

Brine.—The British productions of salt amounts to about 2,000,000 tons per annum, of which 90 per cent. is white salt made from brine. The balance of 10 per cent. is mined chiefly in Cheshire as rock salt; it is of dark-red color, and is suitable only for purposes where a high degree of purity is not essential. All the salt made near Middlesbrough is made from brine by evaporation. Fully saturated brine contains 26½ per cent.

of salt; a fair working strength may be roughly taken at 25 per cent.

In Cheshire the brine is formed by surface water finding access to the rock salt, quickly becoming fully saturated, and then flowing for long distances through crevices or "runs" to the point where it is pumped up. Brine so formed is called "natural brine," and has the enormous advantage of being so abundant that it can be raised at the lowest possible cost by means of large and powerful pumps. As its saturation takes place far away from the pumping station, no disturbance of foundations occurs at the latter through abstraction of the mineral beneath, although much-tried farmers, miles away, find their fields subsiding, until small lakes, having steep and broken sides, are formed. Meanwhile, at the pumping station the brine is abundant, strong, cheap, and pure; for in its long and gradual course underground insoluble particles held in suspension become precipitated. The Cheshire salt industry, therefore, enjoys the advantage of an ideal position, so far as getting the brine is concerned; and when the salt produced has been conveyed some 30 miles by canal, it commands the tonnage of Liverpool for its export. The disadvantage lies, of course, in the 30 miles of canal, which is navigated by means of steam barges carrying about 250 tons, each of which tows a string of smaller barges. These enter any dock in which the ship requiring the salt is lying; and they are admirably fitted for rapidly putting their cargoes on board.



OIL-BOX JACK, DELAWARE & HUDSON CANAL CO.

Boring of Wells.—At Middlesbrough, as already stated, brine is obtained entirely by boring deep wells. Up to 1886, with two exceptions, these were all bored by the Cumberland Diamond Boring Company, using the diamond boring process, which is familiar to engineers. A number of black diamonds are fixed with their cutting edges projecting from the end of a short tube, called a crown, which is screwed on the bottom of a core tube about 18 ft. long, and varying in diameter according to the size of the well to be bored. The whole is rotated by hollow rods, through which a pressure of water is maintained. By this means a solid core is obtained, and the process is therefore valuable for prospecting; but the large sums charged for the wells bored in this way, together with the cost and slowness of repairing them, were threatening to destroy the salt industry at Middlesbrough altogether, when Messrs. Tennant & Partners obtained information which led to the introduction of the method of drilling practised in the American oil regions, where a large number of wells have been put down, and valuable experience obtained. The success of this method was immediate and complete; wells 1,000 ft. deep were sunk in three weeks instead of as many months, with a corresponding reduction in cost. It completely superseded the diamond boring, and was found so much more efficient for repairing holes, as well as for the original drilling, that not one of the 55 wells now in operation at Middlesbrough is without its derrick and American apparatus.

Free-falling Tools.—Drilling is effected by the use of free-falling tools, suspended by a cable. The weight of the tools being about 18 cwt., and the height of fall about 3 ft., blows are given of sufficient force to pierce the hardest rock. The face of the chisel being blunt, the drillings are pounded to powder, and mixed with water in the hole. After drilling from 3 ft. to 5 ft. depth, the tools are rapidly withdrawn, and a sand pump attached to a separate rope is let down in order to remove the detritus, after which the tools are again used.

Derrick.—The "rig," as it is called in America, bears evidence of having been developed in a country where wood is plentiful; and its rough-and-ready character often excites the surprise and disapproval of English engineers. But "handsome is that handsome does," and respect for the rig grows with knowledge of what can be effected by its use in skilful hands. It consists of a derrick 74 ft. high, 20 ft. square at the base, and 3 ft. at the top, surmounted by a crown pulley, over which passes the drilling cable or tubing rope, and a snatch block for the sand-pump line. A bull wheel and drum, driven by an endless rope which is rapidly thrown on or off as required, takes the coil of drilling cable for lifting or lowering tools or tubes. A walking beam, attached at one end to a crank, gives the necessary motion to the drilling tools, and afterward to the pump rods. The crank has a throw of 2 ft., giving a stroke of 4 ft. to the end of the beam, to which the drilling cable is attached by means of an adjustable screw; each revolution of the crank thus produces one blow of the drilling tools. The reel carrying the sand-pump line is worked by a friction pulley. The whole work is done by two men. The driller standing by his tools has within reach the "telegraph line" for controlling the engine; the reversing line attached to the link motion on the engine; the sand-reel lever controlling the sandpump line; and the brake on the bull wheel, which controls the drilling cable and tools.

Drilling Tools.—The tools used consist of a chisel or "bit," stem 32 ft. long, jars, sinker bar 10 ft. long, and rope socket. These are called a "string of tools," and are altogether about 60 ft. long. They are connected by taper screw joints. This joint gives great strength; a few turns bring it home, and an arrangement of levers screws it up so tightly that it does not often unscrew in use, notwithstanding the vibration to which incessant blows subject the tools. The jars are a pair of links having a vertical play of 9 in.; they are for the purpose of freeing the tools if jammed or fastened in any way, by enabling the driller to give a succession of upward blows which loosen the tools, no matter how firmly they may be held. The temper screw is an ingenious contrivance for attaching the cable to the walking beam, and enables the driller to slacken or tighten the cable, and to cause the tools to revolve when drilling. What can be effected by these appliances in the hands of a highly skilled driller is little short of the marvelous. Holes have been drilled nearly a mile in depth, perfectly straight and perfectly round. In Austria, indeed, a hole is reported to have been drilled to a depth of over 6,000 ft.; but the deepest American hole, at Pittsburgh, is 4,618 ft.

Accidents.—The driller's only knowledge of the tools while in the borehole is through the cable, which his hand never leaves while drilling. Extraordinary complications sometimes arise; a faulty joint may unscrew or a tool break, the upper end of which may be driven quite aside from the line of the hole. In the effort to recover it, other tools may be lost, until perhaps a ton of iron blocks the well. On all this a "run in" may occur, burying the whole possibly 100 ft. deep, and at 1,000 ft. or more below the surface. With patient and wonderful skill the hole is cleaned out, tool after tool withdrawn, and the cause of the mischief straightened up and got out. Or the hole may collapse, burying the tools and "sticking" the jars. Then the cable is cut at the lowest accessible point; the hole is lined with tubes, which follow the tools down; the buried tools are got hold of, and by the action of jars are drawn

out inch by inch. Sometimes, though rarely, holes have to be abandoned as the result of such accidents.

Sinking and Lining of Middlesbrough Wells.—The diameter of the Middlesbrough wells is 8 in. After construction of the rig. the first process is to drive down 10-in. tubes, furnished with a strong shoe, through the surface clay, sand, gravel, etc., to a depth of from 80 ft. to 130 ft., till the sandstone is reached; for which purpose the rig is temporarily transformed into a clumsy-looking but efficient pile driver. After this the drilling begins. Thicknesses of from 300 ft. to 700 ft. of water-bearing red sandstone are passed through, then red marl down to the white stone overlying the salt, then rotten marl, and then the salt bed; the drilling stops at the bottom of the salt. The 8-in. hole is then lined, either throughout from top to bottom, or else only through the bottom 200 ft., which is the region of falls of marl. For this bottom portion ½-in. tube is used of 5¼ in. bore. If the hole is lined higher up, the tubes are ¼ in. thick and 6¼ in. bore; at the couplings they are then 7¼ in. in diameter outside.

Pumping of Brine.—As soon as the well is bored, the pump tubes in place, and the pump rods attached, the small cavity occupied by the well in the salt bed will be filled with fully saturated brine; and the pump being started at the normal speed of 12 to 14 strokes per minute, the first discharge will be water, until the brine, passing up the suction pipe, appears in a muddy stream. It quickly clears, and as quickly becomes weak, through the exhaustion of the contents of the cavity, which is as yet small. Water is found in the sandstone within 20 ft. of the surface, and, standing in the annular space, balances the column of brine so far as the difference in their specific gravity permits. A column cf water 1,200 ft. supports one of brine having a height of nearly 1,000 ft.; the pump, therefore, has really to lift the brine only about 200 ft. A new well, if working properly, increases daily in yield as the cavity in the salt bed becomes enlarged through the removal of salt, and thereby presents a larger area of salt surface for solution. Owing to its greater specific gravity, the strongest brine is always found at the bottom of the well; and if the pumping is considerable, brine of decreasing strength, or even fresh water, will occupy the upper part of the cavity. The solvent power of the water, of course, steadily becomes less as full saturation is approached, until it ceases altogether. The result is that more salt is removed from the top of the bed than from lower down; and thus the shape of the cavity should become that of a flat funnel or shallow inverted cone, depending somewhat on how the well is pumped, whether so fast as to yield weak brine or not. This has proved to be what really happens. Wells bored at from 40 to 60 yards distance from old wells have found the cavity already formed and of a depth which, considered in relation to the salt removed, confirmed this theory. In another case a fall of rock broke the well tubes. The fallen stone was drilled through, and fresh tubes inserted to the cavity beneath it. After the pumping had been resumed, the stone slipped down 1½ ft., breaking the tubes again. It was again pierced and the process repeated until the stone was lowered 6 ft., showing that solution of the supporting side of the funnel had allowed the stone to slip down. The pumper confessed defeat, and now pumps from the top of the stone; but he bides his time in the belief that science will eventually provide an explosive which shall create a sufficient disturbance in the very heart and vitals of that obdurate stone. Last, but perhaps not least, an abandoned cavity at Nancy having been pumped dry, was entered, and found to be of the shape indicated. It is obvious that the funnel shape of the cavity is an important matter, and an unfortunate one, for pumping, because it removes support from the neighborhood of the tubes, where it is most needed; and heavy falls of marl and rock occur, which break the tubes, no matter how strong they are, although light falls may be resisted and are known only by the discoloration of the brine. Half-inch steel lining tubes are used; and with this thickness the worst bent and broken tubes after a fall have, with great strain and difficulty, been so far straightened as to be got out by a steady pull with two 50-ton jacks; but in a well with ⅜-in. steel tubes the bend was such that withdrawal was impossible, and the well had to be abandoned. After a fall, weak brine or water is obtained; the invaluable rig is detached from the pumping gear, and is used to withdraw the tubes above the break, generally leaving from 60 ft. to 100 ft. in the well. The tools are then strung up, and an attempt is made to drill down by the side of the old tubes, and to put fresh tubes in. This operation is often attended with endless perplexities and difficulties; nevertheless, wells have been repaired in this way many times. Tools are often lost in this cleaning-out process; in one instance a string of tools, cable and all, went down a cavity, and remain there; and yet the well is working still. The number of wells which have been pumped and afterward abandoned for various reasons is believed not to exceed ten.

Yield and Strength of Brine.—Wells vary considerably, both in yield and in strength of brine. This may be due to the existence of earthy matter, which may cover the salt with a coating of mud, and thus check solution; or it may be due to defective couplings or tubes, which would permit dilution of the brine by the entrance of water into the pump tubes from the annular space surrounding them. A well pumping 10 hours per day, and yielding 200 tons of salt in brine per week, would be considered doing good work.

Surface Subsidence.—The question of possible subsidence of the surface has naturally excited a good deal of interest in Middlesbrough. In Cheshire the flooding of old rock-salt mines and the subsequent pumping, as well as the removal of the mineral from the course of the "runs," have led to serious subsidence, and to extraordinary behavior on the part of houses, roads, streams, and bridges; but at Middlesbrough the depth of the salt bed is so much greater, and the character of the strata so different, that it does not follow the same results will occur. It is believed that great arches will form themselves over the funnel-shaped cavities in the rock-salt, from point to point of support; or that the interstices left by broken masses of fallen rock will equal the bulk of salt removed, and will so support the surface. On the other hand, it is the opinion of experienced persons in Cheshire that subsidence will ultimately take place; and to this result the experience of mining engineers seems to point. All that can so far be said with certainty is that no sign of subsidence has yet shown itself.

Filtration and Evaporation of Brine.—On reaching the surface the brine is conveyed in pipes to a filter bed, constructed on the pattern of ordinary waterworks sand filters. These act well, and pass a clear bright brine to the reservoir, whence it is pumped to the pans for evaporation Notwithstanding the fact that endless efforts have been made to improve the method of evaporation, and that a large number of plans have been devised for this purpose, yet to-day, just as 1,800 years ago, open pans are used, having heat passed under them. The only difference is that the Romans used pans made of lead, and not more than a few feet square; while to-day much larger pans, made of steel and iron, are employed. The ordinary size of common salt pans is 60 ft. × 24 ft. × 1½ ft. deep. The pans are set upon longitudinal walls, which form flues to convey the products of combustion from fireplaces at one end of the pan to the chimney at the other. As the water is driven off by evaporation, the salt crystals form on the surface of the brine, and gradually sink to the bottom. They are drawn by rakes to the side of the pan, and lifted out and deposited upon decks or "hurdles," from which the adhering brine drains back into the pans.

Salt.—Fine salt is obtained from salt which is boiled, the fineness of grain depending upon the temperature at which the brine is evaporated—the higher the temperature, the finer the grain; the lower the temperature, the larger the crystals. Block salt or "squares" are obtained by drawing off boiled salt at short intervals into moulds; the squares are afterward dried by surplus heat from the pans. Table and dairy salt are obtained by grinding squares. Common salt is drawn every other day from brine kept at about 190° F.; fishery is drawn every 7 or 14 days, according to grain, from brine kept at about 100°. All these processes are very simple, yet the salt manufacturer is not without his difficulties and perplexities; and a certain degree of skill and good management is essential to the successful prosecution of this, as of every other industry.—*Practical Engineer.*

PROGRESS IN FLYING MACHINES.

BY O. CHANUTE, C.E.

(*Continued from page 449.*)

No. 17 flying machine of M. *Hargrave* is described in his twelfth communication to the Royal Society of New South Wales, read August 3, 1892. The total weight of the apparatus is 64.5 oz., or 4.03 lbs., including 12¾ oz. for the strut and body plane, so that the engine and boiler, including 5 oz. for spirit fuel and water, weighs 3.25 lbs., and develops 0.169 horse power, or at the rate of 19.2 lbs. per horse power—a very remarkable achievement.

The boiler is of the "Serpollet" type, made of 12 lineal feet of ¼ in. copper tubing (steel pipe could not be got in Sydney), in the form of a double-stranded coil, encased in

asbestos, and placed just over the backbone of the apparatus. The fuel is methylated spirits of wine, drawn from a tank placed above the boiler, vaporized, mixed with air and spurted into the furnace. As much as 6.9 cub. in. of water have been evaporated by 1.7 cub. in. of spirit in 80 seconds, making 182 double vibrations of the propelling wings, say, 2.35 per second, and developing 0.169 horse power.

It was estimated that if the apparatus were loaded with 10 oz. more of spirit and water, and thus made to weigh the same as the compressed-air machine No. 12, which flew 343 ft., then the steam apparatus No. 17 would possess a sufficient store of energy to fly 1,640 yds., or nearly 1 mile.

But M. *Hargrave* has done still better, for in March, 1893, he prepared a paper, which was presented to the Conference on Aerial Navigation at Chicago, August 2, 1893, in

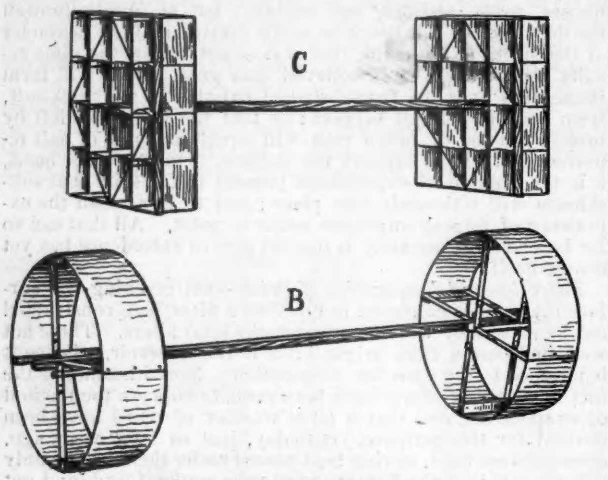


FIG. 80.—HARGRAVE—1893.

which he gave data concerning his No. 18 flying machine. This apparatus is also driven by a steam-engine which weighs, with 21 oz. of fuel and water, an aggregate of 7 lbs., and indicates 0.653 horse power, or at the rate of 10.7 lbs. per horse power; so that, roughly speaking, the weight of the motor has been doubled, and the power has been increased fourfold.

Four boilers were constructed. The final one was made of 21 lineal feet of $\frac{1}{4}$ in. copper pipe, with an internal diameter of 0.18 in., and arranged in three concentric vertical coils whose diameters were 1.6 in., 2.6 in., and 3.6 in. respectively. It weighed 37 oz., but it is now known "that a coil of equal capacity can be made weighing only 8 oz., and still excessively strong." The cylinder is 2 in. diameter, with a stroke of 2.52 in. The feed-pump ram is 0.266 in. diameter, and the piston valves 0.3 in. diameter. On one occasion this motor evaporated 14.7 cub. in. of water with 4.13 cub. in. of spirit in 40 seconds. During a portion of the time it was working at a speed of 171 double vibrations per minute.

M. *Hargrave* gives no data concerning the flight of his last two (steam) machines. He states that 11 different burners have been tried, and that the flame striking the water boiler first has a tendency to vary the supply of heat to the spirit holder. From this it is inferred that he is struggling with the same difficulties already encountered by *Stringfellow*, by *Moy*, and by *Maxim* in regulating and keeping alight spirit burners when the apparatus gets under forward headway; but this difficulty, while a serious one, will doubtless be eventually overcome by persistent experiment, and we may then expect flights of astonishing lengths.

Seeing now his way to an adequate motor and to extensive flights in the near future, M. *Hargrave* recently turned his attention to experiments upon curved surfaces, and to the seeking for a better disposition of the sustaining surfaces or body planes. He had described the eccentricities of a curved strip in the form of a segment of a hollow cylinder, when exposed to the wind, in his paper No. 12 to the Royal Society of New South Wales, read August 3, 1892, and he describes some of his experiments with "cellular kites," in his paper read in the Aerial Navigation at Chicago, August 2, 1893.

The "cellular kites" constitute quite a new departure, and practically consist of superposed aeroplanes connected together in pairs. *B*, in fig. 80, shows the simplest form. This consisted in two hollow cylinders of aluminium, each 13 in. diameter by $4\frac{1}{3}$ in. deep, mounted 30 in. apart upon a connecting stick, and weighing $14\frac{1}{4}$ lbs. The kite-string was attached 11 in. back from the forward section, and as a consequence of the angle of incidence thus produced, the apparatus mounted upon the wind. Its particular behavior is not described in the paper. *C*, in fig. 80, shows a kite with 16 cells, the length of each being 3 in., by a height of 3 in., and a breadth of 3 in. It was made of cardboard, and the two sections were 22 in. apart, the point of attachment of the kite-string being $6\frac{1}{2}$ in. distant from the forward section, while the weight was 10.5 lbs. This seems to indicate that this kite flew at a steeper angle than the preceding, although we should expect the reverse, in consequence of the greater proportion of sustaining surface. M. *Hargrave* says, "These kites have a fine angle of incidence, so that they correspond with the flying machines they are meant to represent, and differ from the kites of our youth, which we recollect floating at an angle of about 45°, in which position the lift and the drift are about equal. The fine angle makes the lift largely exceed the drift, and brings the kite so that the upper part of the string is nearly vertical."

Kites *E* and *F*, fig. 81, are of exactly the same size and weight, consisting of one cell, 4 in. long, 10.7 in. broad by 6.25 in. high, constructed of wood and paper, and weighing 3.25 lbs.; the two sections are 21.25 in. apart, and the string is fastened 7.25 in. back of the forward section. The only difference is that kite *E* has its horizontal (top and bottom) surfaces curved to a radius of 4.5 in., while all the surfaces of kite *F* are true planes. The result is that when kite *E* is flown with the convex sides up, it pulls about twice as hard on the string as kite *F*, so that, as M. *Hargrave* says: "A flying machine with curved surfaces would be better than one with a flat body plane, if the form could be made with the same weight of material."

M. *Hargrave*, in this last paper, figures and describes two other forms of cellular kites with which he has experimented, and points out that the rectangular form of cell is collapsible when one diagonal tie is disconnected, so as to make it easy of transportation. He says: "Theoretically, if the kite is perfect in construction and the wind steady, the string could be attached infinitely near the center of the connecting stick, and the kite would fly very near the zenith. It is obvious that any number of kites

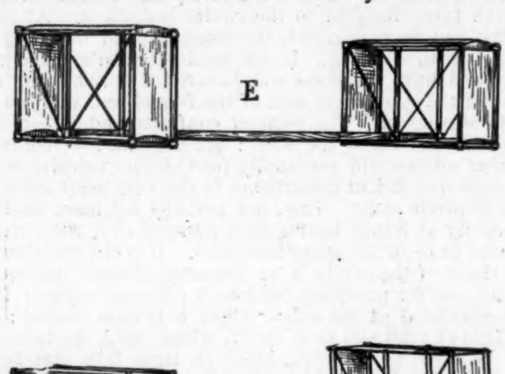


FIG. 81.—HARGRAVE—1893.

may be strung together on the same line, and that there is no limit to the weight that may be buoyed up in a breeze by means of light and handy tackle. The next step is clear enough—namely, that a flying machine with acres of surface can be safely got under way, or anchored and hauled to the ground by means of the string of kites."

He duly gives credit to M. *Wenham* for suggesting the superposition of planes in 1866, and it is an interesting circumstance to note that at the same Chicago conference, a

paper from M. *Wenham* was read suggesting a course of experiments with kites, to determine the best arrangement of superposed aeroplanes and the conditions of equipoise.

Such are the labors of M. *Hargrave* up to the present time. He no longer troubles himself about the general problem of man's eventual success in navigating the air, but he says: "The people of Sydney who can speak of my work without a smile are very scarce; it is doubtless the same with American workers. I know that success is dead sure to come, and therefore do not waste time and words in trying to convince unbelievers."

Instead of this, he constructs machines and reports the results in detail, so that others may repeat his experiments. He says that the record of unsuccessful experiments takes up a considerable portion of his notes, and further, that "there is no use in the mind's conceiving an idea, if the hands are not ready to carry out the work skillfully, in the absence of reliable assistance, and if the design be found faulty, the whole thing should be begun again without trying to use up old machines. The question of intricate workmanship and costliness is being continually battled with; my constant endeavors are directed to making the machines simple and cheap, so that any one who doubts can verify my work, provided his hands are as skillful as mine, and I am sure that the photographs show clearly that the workmanship is anything but first-rate."

He began with small, cheap models, and has gradually enlarged their size, and obtained flights longer than any heretofore accomplished. It is noticeable that the heavier the model, and the smaller the sustaining area in proportion to the weight, the more successful has been the flight. He may not be the first man to ride at will upon the air, but he deserves to succeed.

In November, 1890, M. *Hiram S. Maxim*, the celebrated American inventor of a writing telegraph, of several systems of electric lighting, and of the "Maxim automatic machine gun," addressed a letter to the New York *Times*, in which he stated that, before sailing back to England, he thought it would be well to state what he was doing toward constructing a flying machine which had been alluded to lately by the American press. Among other things he said:

I would say that among the large number of societies to which I belong in England, the Aeronautical Society is one, and need I say that I am the most active member? At the present moment experiments are being conducted by me at Baldwin's Park, Bexley, Kent, England, with a view of finding out exactly what the supporting power of a plane is when driven through the air at a slight angle from the horizontal. For this purpose I constructed a very elaborate apparatus, provided with a great number of instruments, and arranged in such a manner that I can ascertain accurately the efficiency of a screw working in air, the amount of power required to drive a screw, the amount of push developed by a screw, the amount of slip, and also the power required for propelling planes through the air when placed at different angles, as well as to ascertain the friction and all other phenomena connected with the subject. I have been experimenting with motors and have succeeded in making them so that they will develop 1 horse power for every 6 lbs. My experiments show that as much as 133 lbs. may be sustained in the air by the expenditure of 1 horse power; of course, it is premature now to express any opinion; still, if I am not very much mistaken, and if some new phenomenon, which I do not understand, does not prevent it, I think I stand a fair chance of solving the problem, and I think I can assert that within a very few years some one—if not myself, somebody else—will have made a machine which can be guided through the air, will travel with considerable velocity, and will be sufficiently under control to be used for military purposes. I have found in my experiments that it is necessary to have a speed of at least 30 miles per hour, that 50 miles is still more favorable, and that 100 miles would seem to be attainable. Everything seems to be in favor of high speed.

Whether I succeed or not, the results of my experiments will be published, and as I am the only man who has ever tried the experiments in a thorough manner with delicate and

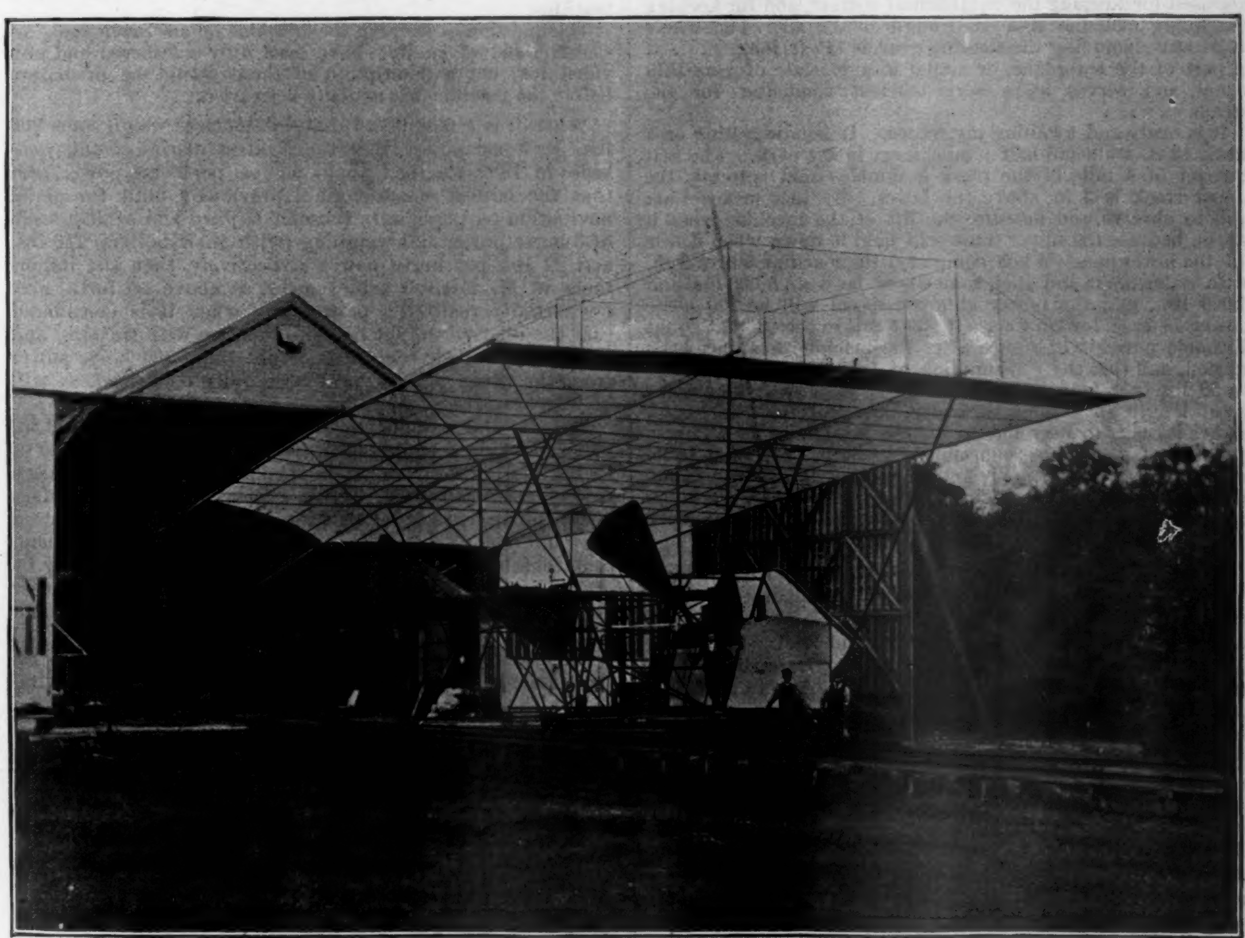


Fig. 82.—MAXIM—1892.

accurate apparatus, the data which I shall be able to furnish will be of much greater value to experimenters hereafter than all that has ever been published before.

In May, 1891, M. *Maxim* again visited the United States, and he gave to various newspaper reporters, notably to one from the New York *Sun*, some particulars concerning the flying machine, or "first kite of war," which he was building in England, and upon which he had spent up to that time (including the preliminary experiments) some $45,000.

He described the apparatus with which he had made his preliminary experiments, to ascertain accurately the supporting power and resistance of air to aeroplanes at small angles of incidence, and then continued as follows:

My large apparatus is provided with a plane 110 ft. long and 40 ft. wide, made of a frame of steel tubes covered with silk. Other smaller planes attached to this make up a surface of 5,500 sq. ft. There is one great central plane, and to this are hinged various other planes, very much smaller, which are used for keeping the equilibrium correct, and for keeping the flying machine at a fixed angle in the air. The whole apparatus, including the steering gear, is 145 ft. long. . . . A part of the aeroplane, or actual kite, is made of very thin metal, and serves as a very efficient condenser for the steam. . . .

It is ready and awaiting my return. It is now resting on a track 12 ft. wide and half a mile long, in my park. The first quarter of a mile of the track is double—that is to say, the upper track is 3 in. above the lower. By that means I am able to observe and measure the lift of the machine when it starts, because the upper track will hold it down when it lifts off the lower one. When completed the machine will weigh, with water tanks and fuel, somewhere between 5,000 lbs. and 6,000 lbs., and the power at my disposal will be 300 horse power in case I wish to use it; but it is expected that about 40 horse power will suffice after the machine has once been started, and that the consumption of fuel will be from 40 lbs. to 50 lbs. per hour. The machine is made with its present great length so as to give a man time to think; its length makes it easier to steer and to change its angle in the air. Its quantity of power is so enormously great in proportion to its weight that it will quickly get its speed. It will rise in the air like a sea-gull if the engine be run at full speed while the machine is held fast to the track; and if it is then suddenly loosened and let go.

M. *Maxim* very judiciously refrained from furnishing drawings or detailed descriptions of an apparatus which was still in process of evolution, and which he might want to modify as he proceeded in erection and trial. Indeed, it is probable that he has varied considerably from the various arrangements which he has patented from time to time,* so that drawings and descriptions made from these might be wide of the mark.

The important, the vital feature, however, he recognized to be the motor, and to perfecting this he gave his first attention. In steam motors he seems to have accomplished wonderful results, hitherto quite unreached, and in an article published in the *Century Magazine* for October, 1891, after describing and illustrating the experimental whirling machine with which he had gathered his preliminary data, he gives the following account of what he had accomplished up to that time with the motor:

I have come to the conclusion that the greatest amount of force with the minimum amount of weight can be obtained from a high-pressure compound steam-engine, using steam at a pressure of from 200 lbs. to 350 lbs. to the square inch, and lately I have constructed two such engines, each weighing 300 lbs. These engines, when working under a pressure of 200 lbs. to the square inch, and with a piston speed of only 400 ft. per minute, develop in useful effect in push of screws over 100 horse power, the push of the screws collectively being over 1,000 lbs. By increasing the number of turns, and also the steam pressure, I believe it will be possible to obtain from 200 horse power to 300 horse power from the same engines, and with a piston speed no greater than 850 ft. per minute.† These engines are made throughout of tempered steel, and are of great strength and lightness. The new feature about my motors, however, is the manner of generating steam. The steam generator itself, without the casing about it, weighs only 350 lbs.; the engine, generator, casing, pumps, cranks, screw-shaft, and screws weigh 1,800 lbs., and the rest of the machine as much more. With a supply of fuel, water, and three men, the weight will not be far from 5,000 lbs. As the foregoing experiments have shown that the load may be 14 times the push of the screw, it would appear that this machine ought to carry a burden, including its own weight, of 14,000 lbs., thus leaving a margin of 9,000 lbs., provided that the steam pressure is maintained at 200 lbs. to the square inch. The steam generator is self-regulating, has 48,000 brazed joints, and is heated by 45,000 gas jets, gas being made by a simple process from petroleum. When the machine is finished the exhaust steam will be condensed by an atmospheric condenser, made of a great number of very thin metallic tubes, arranged in such a manner that they form a considerable portion of the lifting surface of the aeroplane. The greater part of the machine is constructed from thin steel tubes. I found that these were much more suitable for the purpose than the much talked-of aluminium; still I believe that if I should succeed in constructing a successful machine, it would lead to such improvements in the manufacture of aluminium products that it will be possible to reduce greatly the weight of the machine.

The question of keeping the machine on an "even keel," of steering, and of landing, have been duly considered and provided for, but a description of these would be premature before the machine has actually been tried.

When it is remembered that locomotives weigh some 200 lbs. per horse power, that the lightest marine (launch) engines in 1889 weighed about 60 lbs. per horse power, and that the largest steam-engines previously built for aerial navigation purposes were those of *Giffard* and of *Moy*, each of 3 horse power and weighing (with their boilers) 110 lbs. and 27 lbs. per horse power respectively, then the importance of M. *Maxim's* achievement, as above set forth, may be partially realized; particularly when it is considered that the relative weight tends to increase with the size, and that M. *Maxim's* expectations of obtaining 300 horse power from the same engines have been fully confirmed, as will be seen hereafter.

Moreover, as exhausting the steam into the air would involve carrying a supply of water amounting to some 20 or 25 lbs. per horse power per hour, and this would have been simply prohibitory, M. *Maxim's* plans included a surface aero-condenser, in order that the same water might be used over and over again. This was a wholly unsolved problem, such tentative experiments as had been tried previously by others having indicated weights of 50 lbs. to 150 lbs. per horse power, as necessary for efficient aero-condensers, and this would also have been prohibitory.

M. *Maxim* proposes to solve this problem by making all the frames of his apparatus of hollow tubes, and connecting therewith a condenser consisting of a large number of wide, flat, or film tubes—that is to say, of tubes of thin metal having a flat bore, through which the steam will pass in thin films of considerable width; these film tubes being so arranged that in the forward motion of the machine the air will impinge upon them, thus effectually cooling them and condensing the steam therein. This aero-condenser is utilized as a part or the whole of the sustaining surface, or there may be substituted therefor a large flexible bag or chamber, connected at the forward part with the exhaust steam-pipe, and at the rear end with the hot well, or directly with the suction-pipe of the feed-pump. He relies, of course, upon the increased condensation produced by air currents due to the forward motion of the machine, and the extent of the condenser is therefore a matter for experiment, so that its exact weight cannot be settled in advance.

The horizontal angle of incidence in flight is to be maintained by a "Gyrostat," which consists in a gyroscopic wheel rotating rapidly, suspended by universal joints and connected with two horizontal rudders, one at the front and the other at the back of the apparatus, so as to act upon them instantly (through the well-known property of the gyroscope to continue rotating in the same plane), in case any tendency occurs to deviate from the angle of incidence with the horizon.

The whole of the apparatus is to be thoroughly stayed by diagonal wire ties, so as to make every part rigid and prevent deformations under varying wind pressures.

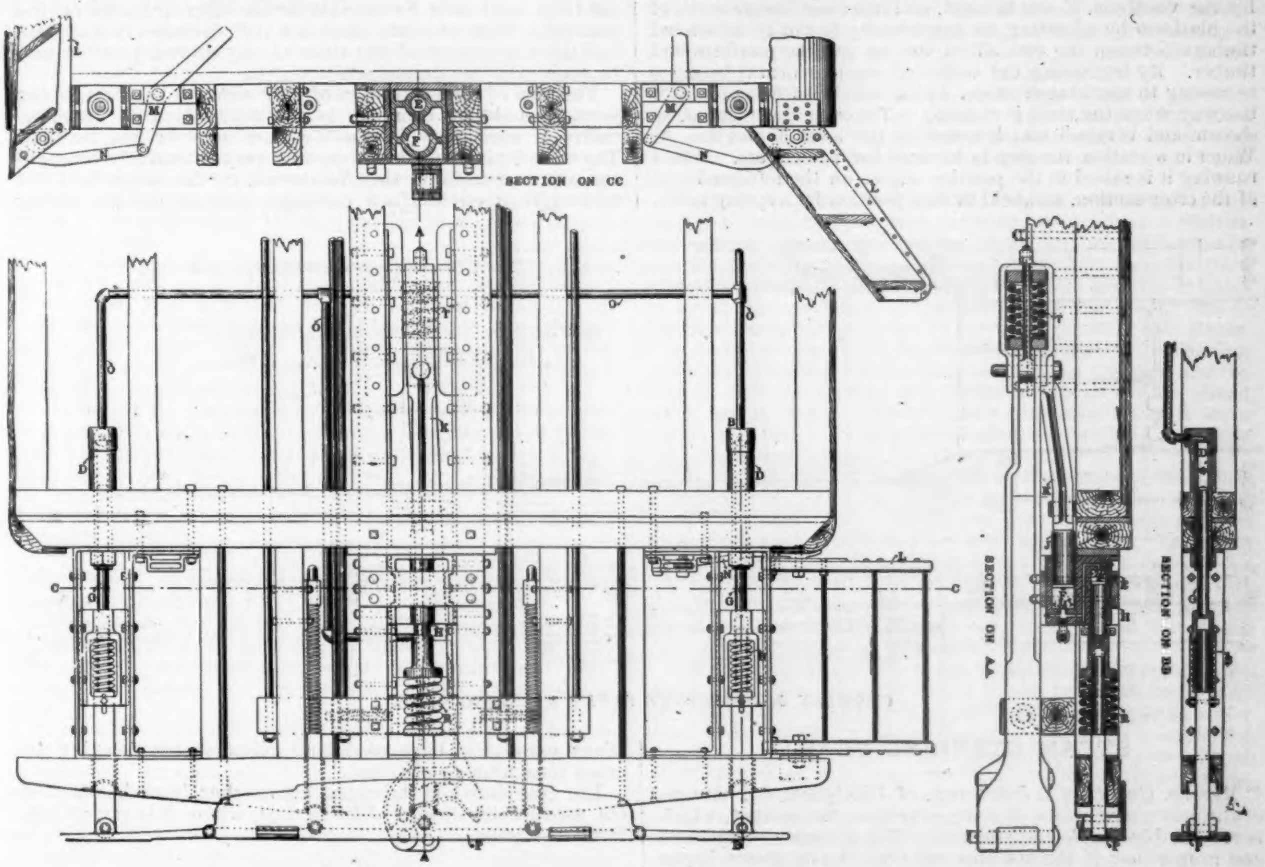
Fig. 82, engraved from a photograph kindly furnished by M. *Maxim*, exhibits the main features of the apparatus. It does not show the front or back rudders, which have been removed, nor the side wings, set at a diedral angle, to

* British patents Nos. 10,359 and 16,883, A.D. 1889; No. 19,228, A.D. 1891.
† The piston speed of an express locomotive is about 1,000 ft. per minute.

preserve the transverse stability, nor sundry possible keel-cloths or auxiliary planes intended to promote the same object. It exhibits the central or principal aeroplane, with the forward end facing the observer. This main aeroplane is understood to be 50 ft. wide, about 58 ft. long, and slightly concave in the direction of its length, while it is trussed and stiffened in every direction by wire stays. The condenser is indicated by the dark shading at the front of the main plane, and, as will readily be seen, can be largely increased in surface, but, however, at the expense of added weight. The driving screws are placed at the rear, and are understood to be 17 ft. 10 in. in diameter, the speed of rotation varying, of course, with the power exerted.

The whole apparatus is mounted upon wheels, running over a railway track, so as to acquire sufficient speed to rise upon the air, and the three men who are grouped about the front may enable the reader to gather by comparison some general conception of the colossal dimensions of this flying machine.

(TO BE CONTINUED.)



LEONARD'S HYDROSTATIC BUFFER.

The object of this buffer is to provide means of holding adjacent cars firmly together, thus increasing the friction between the buffers and lessening the amount of oscillation due to curves and uneven tracks.

In the different views on the drawing the same letter refers to the same part. Two center cylinders, *E* and *F*, cast in one piece, are firmly secured between the center sills of the car. The cylinder *E* is fitted with a ram *H*, which is forced outward against a cross-head pressing against the spring *R*, which transmits the pressure to the buffer *P*. The cylinder *F* is fitted with a ram *J*, which is forced against the pressure-bar *K*. This pressure-bar is secured to the back end of the draw-head. When pressure is admitted to cylinder *F* by the pipe *O*, the ram *J* is driven back and the draw-head is drawn in. At the same time the pressure passes through the port shown to the cylinder *E* and forces the buffer *P* outward; thus the cars are drawn firmly together. Two side cylinders *D*, *D*, are secured in the end sill of the car. Each of these is fitted with a ram *G*, which bears against a cross-head and transmits the pressure through a spring *S* to the buffer *P*. The buffers *P* are thus pressed together at three points on their length. The cylinders *F*, *E*, *D*, *D*, are all connected to the same system of piping, and the pressure per square inch will be the same in each. This pipe *O* is connected to a pump and reservoir inside the car. The pipes, cylinder, and reservoir are filled with water or other fluid.

In the ordinary systems of coupling cars used in this country with couplers of the Janney and Miller type, the couplers and buffers are usually so arranged that when the cars are coupled, the springs that force the buffers out are compressed to a certain extent, thus forcing the buffer together and tending to hold the cars steady. The amount of this compression and the subsequent pressure upon the buffers is, however, limited, since in order to effect a coupling the cars must be driven together with sufficient force to compress the buffer springs and allow the couplers to engage. If the springs are too stiff this impact is too great, and will not only damage the cars, but will cause disagreeable shock to the passengers. In some systems the coupler and buffer are so connected by levers or pressure-bars that, as the coupler is pulled forward, the motion is transmitted to the buffer, and the opposing buffers are thus pressed together with greater force. In this case, however, the amount of pressure that can be put on the buffers is limited, since the springs must be compressed and the cars coupled by impact. In the English system of coupling the cars are drawn together and pressure put on the buffers after the cars are coupled by a screw operated by hand. This method, however, is slow and crude, and involves the necessity of a man going between the cars. It is, moreover, inapplicable to automatic couplers.

In the hydrostatic system the pressure is let out from the cylinders when the cars are to be coupled, and a coupling may be thus effected with a slight impact. After the coupling is effected the pressure is pumped into the cylinders by an attendant in the car, and any desired amount of pressure may be put on the buffers. The pressure in the adjacent ends of two cars is pumped up to about the same amount (sufficient to put the springs under a heavy compression), as shown by the gauges.

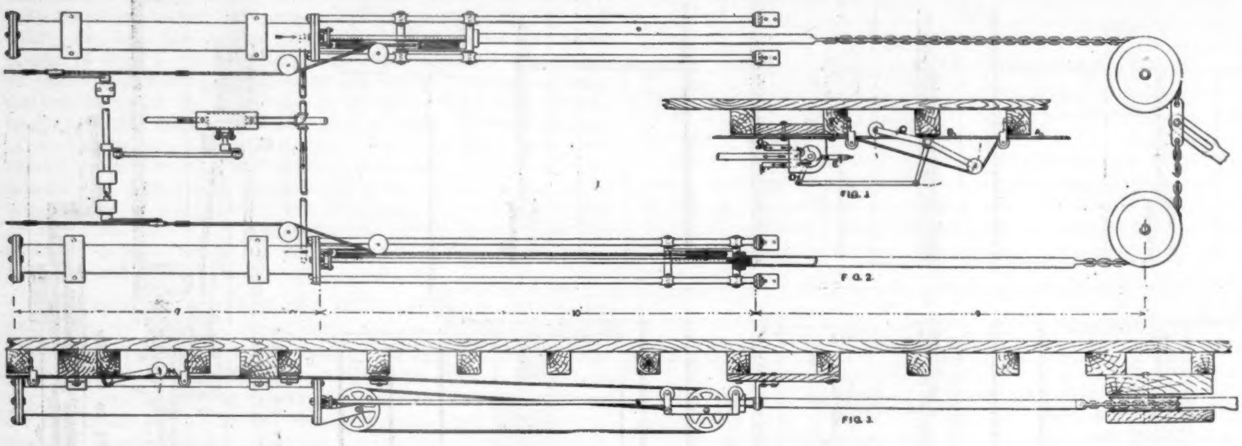
If one buffer has more pressure in the cylinders than the other, the buffer will move toward the car on which there is the smaller pressure. The leakage is very small, and may be supplied by a few strokes of the pump when required. The long buffer plates shown increase the area of friction surface between the buffers, and this, combined with the greater pressure between them, has a marked effect in reducing the oscilla-

tion of the cars. It also tends to hold the end of the car up on uneven tracks. In case of a low joint or depression in the track the truck will drop, and with the ordinary buffer the body of the car will follow the truck, and as the truck rises again the body of the car meets it and produces a shock. With the hydrostatic buffer, however, the friction between the plates is sufficient to hold the end of the car up for the moment as the trucks fall, and a much steadier motion is the result.

In rounding curves, as the cylinders on the end of one car are all connected, one end of the buffer is free to move in while the other moves out, the fluid passing from one side cylinder through the pipe into the other as the rams move, and thus serving the purpose of an equalizing bar to maintain a uniform pressure on each end of the buffer.

In case of a collision the hydrostatic buffer would afford much more protection to the cars and passengers than the ordinary system, both on account of the greater area of buffer, and also because the shock will be better absorbed by the hydrostatic buffer, since the force necessary to compress it is much greater.

In connection with this buffer the platform is extended out nearly to the width of the car body; this gives a wider space for the vestibule, if one is used, and increases the strength of the platform by affording an opportunity to put in additional timbers between the end sill of the car and the platform end timber. By increasing the width of the platform it becomes necessary to use hinged steps, which can be turned up out of the way when the train is running. The step *L* is pivoted, as shown, and is raised and lowered by the lever *M* and link *N*. When in a station the step is lowered for passengers. When running it is raised in the position shown on the left-hand side of the cross-section, and held in that position by a spring latch.



CRAWLEY & JOHNSTON'S STEAM STEERING GEAR.

STEAM STEERING GEAR.

MESSRS. CRAWLEY & JOHNSTON, of Cincinnati, O., have recently put a new steam steering gear upon the market, which is remarkably simple and effective. The general arrangement and proportions of the machine are very clearly shown in our engraving. The principle upon which the machine acts is, that, as the tiller rope is tightened, it opens a valve of a steam cylinder, admitting steam to one end of the same and drawing in the piston-rod, which is attached direct to the tiller of the rudder. As this piston comes in it slackens off on the tiller rope, and thus allows the valve to close and shut the steam valve. As long as the steering wheel is kept revolving, holding the tiller rope taut, the piston will travel forward and move the tiller until it is hard over on one side; but the moment the steering wheel is stopped and the tiller rope allowed to slacken, the piston stops its motion and the tiller is held in the position in which it happens to be at that moment.

Referring to the engraving, fig. 1 shows the arrangement of the tiller ropes as connected with the valve, and also a cross-section of the valve itself. This latter is a rocking valve of the D pattern. The line of rope at the point *A* represents both ropes, one being behind the other. As the line at *B* is tightened, the arm *C* of the bell crank lever is raised, and the lever *D* of the valve moved forward into the position shown. At this point it will be seen that the valve is thrown clear over on one side, and steam enters through the steam pipe *E*, and passes out through the pipe *F* to one of the cylinders. On the other hand, the exhaust of the valve allows the steam to escape from the pipe *G* of the other cylinder and out through the exhaust; thus as long as the valve is held in this position, the piston, which works in the cylinder into which the pipe *F* leads, will continue to travel until it has hauled the tiller hard over, where it is held by a stop.

The arrangement for automatically stopping and adjusting the position of the tiller is shown at the bottom of the engraving in fig. 3. The piston travel is 6 ft., and, as shown, the piston is clear out and the tiller is represented as hard over on the one side. As the tiller rope at *H* is tightened, the valve is moved over, as already described, and steam would be admitted to the front end of the cylinder *I* and the piston drawn in. As it does so the cross-head or traveler, *K*, is drawn back, and this is directly attached to the tiller chains, so that the tiller is thus moved. As it travels back it will readily be seen that the rope *H* is slackened off, and as a consequence of this the valve will be moved to its central position, locking the steam, unless the wheel in the pilot-house is kept turning, holding the tiller rope *H* taut. As the movement of the traveler slacks off three times as much rope at *H* as the distance which it travels, and as the piston travel from the central position to hard over is 3 ft., it will be seen that the wheel in the wheel-house must take up 9 ft. of rope in order to bring the tiller hard over to one side or the other from the central position. This, of course, makes a very delicate arrangement, and the adjustment of the tiller to any desired position may be made with the utmost sensitiveness.

The plan of using cylinders of long stroke for accomplishing work of a similar character is one with which all manufacturers of machinery in the West are more or less familiar. The same long stroke has been used very extensively throughout the saw-mills of the Northwest, in the steam-feed for moving their circular saw carriages, and one concern having heavy excavators have used long cylinders for swinging the crane for a number of years.

The gear shown in the engraving is taken from drawings of one used on the steamer *John Barrett*, where it is giving perfect satisfaction.

EXPERIMENTS WITH STAYLESS BOILERS AND STEEL FIRE-BOXES.*

BY AUGUST VON BORRIES.

I.—STEEL FIRE-BOXES.

Construction of the Boiler.—In consequence of the successful experiments which have been made on North American railways in the application of thin sheets of steel for fire-box purposes, the Royal State Railways of Hanover had a number of boilers made with steel fire-boxes in the years 1891 and 1892, the first of which has now been in service for 12 months. There was also a single steel fire-box put in the old boiler of the shops.

The construction of the new boiler is very similar to the typical American boiler with crown sheet supported by radial stays. These crown stays were chosen in order to avoid the bending of the crown sheet, which usually occurs with the

* Paper read before the Verein Deutscher Machinen-Ingenieure.

ordinary methods of strengthening with vertical and horizontal stay-bolts, and also to simplify the construction as much as possible. The crowns and side sheets of the outer shell of the fire-box can, therefore, also be constructed of thin sheets.

The fire door openings which have been used for the last year are constructed without a ring on the well-known Webb construction. The shell of the boilers has outer and narrow inner welts for the horizontal seams, riveted with four rows of rivets. The circumferential seams of the center course of the boiler run under the outer welt, while the inner welt stops with the end and back plates. The outer welts of the first and third rings butt up against the ends of the sheet of the central course. For connecting the shell with the smoke-box, a ring extending over the two seams was first used; afterward this was cut out with a notch at each seam under the connecting ring of the smoke-box in order to get access to the seams. The notch was then filled up by a filler held with a screw. The thickness of the sheets of the fire-box was calculated for a steam pressure of 180 lbs. to the square inch, under which the boiler works, and were as follows:

Tube sheet, .5 in.; back sheet, .39 in.; side and crown sheets, .35 in.; widest spacing of stay-bolts, 3.9 in.

A tube sheet was first experimented with which had a thickness of only .39 in.; the arch was first constructed on the American plan, supported by three water tubes, and so arranged that it did not come in contact with the sheets of the fire-box, in order to avoid any uneven heating of the latter.

Determination of the Properties of the Sheet.—In consequence of the very favorable experiments which were begun in 1886 leading to an extensive application of steel in the work shops, a number of boilers were constructed entirely of steel, as well as a number of others with copper fire-boxes. For the determination of the character of the steel the following specifications were laid down:

"The sheets of the shell, as well as the outer and inner fire-box walls, must be of first-class quality and of mild, open-hearth steel, with a tensile strength of from 48,000 lbs. to 58,000 lbs. per square inch, giving at least 25 per cent. elongation in a length of 7.9 in. The steel which is used in the smoke-box must have at least 20 per cent. elongation when subjected to the tensile test.

"In testing the sheets and rolled iron of both kinds of steel they must be cooled in water having a temperature of 83° F. from a cherry-red heat, and must show neither cracks nor flaws of any kind when afterward bent through an angle of 180°, the smallest diameter of the curve of which is to be equal to the thickness of the metal. Furthermore, the steel must be readily welded.

"The test pieces for tensile, bending, and hardening tests must be taken lengthwise, as well as crosswise of the rolling direction of the sheets.

"Test pieces: one piece must be cut from each boiler sheet in accordance with the judgment of the inspector. The same kind of steel may be used for angle and rolled braces, stay-bolts, rivets, screws, etc., as was used in the sheets of the shell."

In working, the sheets from different shops showed practically the same tensile strength and elongation, but different hardnesses. An especially hard tube sheet developed a tendency to crack. Those which were hardest, therefore, from a chemical standpoint, were sent back, and an examination of those which had cracked and several other plates gave a high percentage of phosphorus, so that afterward the highest limit of phosphorus for the firebox sheets was put at .04 per cent. in order to obtain a metal which showed no inclination toward detrimental cracks and flaws. As the boiler was already constructed this examination could be only partially complete; still further investigation showed that the phosphorus present was not more than .05 per cent.

It is to be remarked here that more particular attention should be paid to the chemical composition of sheets made in this country than in North America, because raw material here is less likely to be free from deleterious matter than it is in America.

Construction of the Boiler.—The following specifications are laid down for the working of steel plates: "The steel plates must be worked only when they are at a red heat or perfectly cold, and never in a half-heated condition. Flanged plates must be flanged with wooden hammers and afterward reheated and allowed to cool slowly. The outside sheets of the fire-box and those of the shell are to be bent cold. All sheets which are cut under the shears must be beveled off at an angle of from ½ to ⅝ of their thickness. Sheets thus beveled and which cannot be worked by the machine tools must be cut with a flat or cape chisel and a light hammer, and afterward filed. It is not permitted to cut such bevels with heavy chisels and sledge-hammers.

"If it become necessary to reheat a steel sheet, the fire must be so arranged that there is a zone of from 6 in. to 8 in. in breadth between the heated portions and that portion of the plate which is left cold. This zone is for the purpose of doing away with unequal expansion and avoiding the deleterious influences which might result from heating. It is therefore forbidden to limit this zone by covering the sheet with damp lime or ashes.

"In assembling the sheets for riveting, it is desirable that they should be brought together, as far as possible, with screws. Where the use of the hammer is unavoidable, as light a hammer as possible must be used, and it must be employed with the utmost care."

The construction of the boiler offers no special difficulty, and with the exception of the flanges of the tube sheets is worked without any trouble.

Particular attention is paid to the calking, which is to be done on the outside of the seam with a blunt tool, and it has given no trouble whatever.

In this way these places have remained perfectly tight. The seam riveting is relatively made safer and tighter than with the ordinary lap seam, because the changes of form which occur with these latter, in the consequence of the expansion of the metal, does not occur. The metal in the sheet of the shell can also be made about 15 per cent. less in the new method of making seams than in the old.

The cost of building the boiler averages about 80 per cent. of that of the old form of boiler of equal dimensions with a copper fire-box, lap riveted seams, and correspondingly thicker sheets. The weight is also somewhat less than in the old construction.

Handling in Service.—The following recommendations are made for handling the steel fire-boxes in service: "Sudden and unequal heating and cooling of the fire-box walls is to be avoided; while heating and during the ordinary manipulation of the fire, the latter shall be kept as even as possible in order to avoid the admission of cold air at any one place. Large lumps of damp coal must not be thrown against the side sheets. It is forbidden to run with the fire door open. In shaking down and cleaning out the fire, the ash-pan dampers and the blower must be closed; the former must always be closed when raking down. Washing out with cold water is especially forbidden. It is recommended that as long a time as convenient shall be used for raising steam."

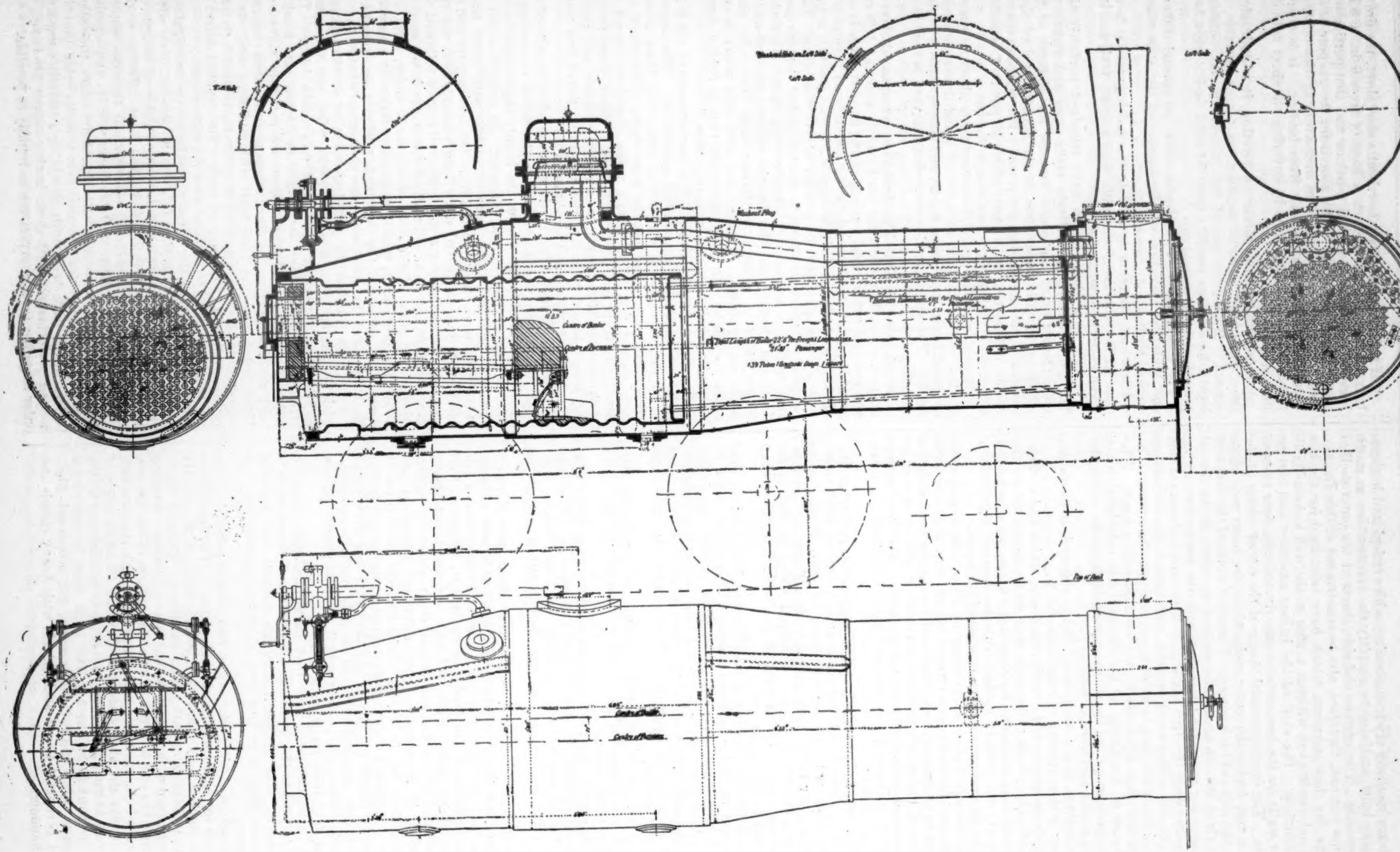
The Experiences in Service.—The performance of the boiler in service was at first but slightly satisfactory. The screwing in of the water tubes, which was done with brass ferrules with check-nuts, could not be kept tight. The check-nuts soon burned out. The escape water therefore caused the tubes, stay-bolts, and riveting to leak. Other screw ferrules with movable fastenings gave no better results, and, finally, the simple iron ferrule was the only thing found that would give lasting tightness to these locomotives.

After a short time a few of the tubes cracked in spite of the rapid circulation which obtained in the boiler on account of the deposition of scale, due to the highly impregnated water taken at the engine house at Hanover. In order to avoid the manifold troubles which were occurring with these water tubes, they were then removed from the locomotives and the brick arch was supported upon ledges attached to the side sheets in the ordinary manner. No evil results followed this movement, so that gradually all of the water tubes were removed. In spite of the heat of the sheet under, near, and above the brick arch, which frequently varies by many degrees, they withstood the expansion perfectly on account of the mildness of the metal, and gave no trouble whatever.

From that time on the principal cause of all the leakages with the water tubes was done away with, and the tubes, stay-bolts, and riveting kept tight very much better. The boilers built at different shops have developed very marked differences in this particular. Some are perfectly tight and fully equal to a copper fire-box; others are only moderately so. These latter have not been built with sufficient care. It is important to establish this point in order that these defects may not be attributed to the use of steel. The slightest defect in construction should be avoided with the utmost care.

It may be stated as the essential results of the investigations which have been made thus far, that no fire-box plate after the short service to which it has been subjected has sprung in the slightest, and that the steel taken from different works for locomotive fire-boxes has given essentially the same results.

What the life of these steel fire-boxes will be, and whether they will compare favorably with copper fire-boxes, time alone can tell. Therefore for the next year it is desirable that the boilers which have been built should be carefully compared in their performances with those having copper fire-boxes, in order to gather further experience as rapidly as possible.



STAYLESS BOILER DESIGNED BY AUGUST VON BORRIES, FOR THE HANOVER STATE RAILWAY.

It is more than probable, however, that the steel tube sheets will prove themselves superior to those of copper. They do not stretch so readily, and the tubes can be made far tighter. The copper tube sheets up to this time have shown many indications of a very short life, and lately several have been removed on account of the defects in the upper flanging and the tearing out of the upper stay-bolts, in consequence of considerable stretching, so that they had to be replaced after two or three years; and one is almost tempted to revert to the old method of the use of crown bars, which is still extensively used in England, or to consider some other method of staying which acts equally well.

On the other hand, the steel fire-boxes at the bottom of the side sheets and beneath the grates have developed a marked tendency to rust, which can only be explained by the deposition of moisture from the heated air on the cooling boiler. The cause of this rusting will be a further reason for avoiding, as far as possible, the putting of locomotives out of service, since the boiler can only be cooled off to any very great extent by washing out. This would be the reason that a similar rusting has not been observed in North America. The service of the sheets which are subjected to the direct action of the fire are still smooth and without any visible deterioration by rust.

A very slight amount of time that the locomotives are out of service acts as a special inducement for the further introduction of steel fire-boxes, thus forming a twofold means of cutting down expenses. In order to establish the final results on a sure basis, each fire-box must be removed which has shown any defect in its operation from the beginning, and to replace it by a steel fire-box of lasting tightness will be a work of no great difficulty.

THE STAYLESS BOILER.

Construction of Boiler.—In preparation for the investigation of economical boiler practice, a few stayless boilers were ordered by the Hanover Railway Company in the year 1886, built on the well-known Polmeyer system of construction, and afterward a larger number were designed differing in form principally in the shape of the shell, in order to obtain the best shape possible, and to cut down the weight of water contained to the lowest practicable amount. Consequently in 1890 the Leinhausen workshops built two stayless boilers, the general design of which is shown by the full-page engraving. The latest construction differs from them in its essential particulars only in that the lower part of the cylindrical shell is closed at the back by an arched sheet.

Furthermore, there are three points at which the cylindrical portion is not riveted to the longitudinal seams, but this was readily welded at the shops of Schulz, Knandt & Company, at Essen. Tests of the strength of these troublesome seams gave about 95 per cent. of the strength of the full sheet. The welding was preferred to riveting in order to keep the sheets as thin as possible.

As the boiler was still far too heavy, and put an excess of weight on the back axle of the three-coupled freight engine, to which it was applied in February and March, 1891, the form was still further modified and the back end made cone shaped, bringing it down to the Lenz form of shell. Instead of the welded longitudinal seams, riveting was again resorted to at a reasonable cost coupled with the use of the double welt.

Of this new construction of internal fire-box boilers four were put in service after a time; four more are being constructed, and 15 like the one illustrated are under contemplation. These differ from the two first built under the Polmeyer system and the first of the Lenz type in the following particulars:

1. The back tube sheet is not rigidly fastened to the shell, but the front end of the flue is attached to the shell by four brackets; the tube sheet can also, since the flue has some flexibility, follow the slight changes in the length.

2. There is no ashpit for the cinders other than that in the bottom of the flue, and the surface of the same, which is subjected to the action of the fire, is entirely free from rivet heads, seams, or other interruptions in the smoothness of the surface, since every such place gives occasion to an increase of wear.

3. The cinders are removed from the bottom of the flue through a trap-door lined with fire-brick, and by means of a special scraper.

4. In order to heat the cold water and draw it out from the bottom of the boiler there is a passageway made of sheet metal covering three of the corrugations of the flue, in which the water is heated to a higher temperature than in other portions, and consequently has an upward flow drawing its supply from the bottom of the boiler.

5. The back end of the flue is closed by means of a cast iron head, which is lined on the fire side with fire-brick and on the back side has an air space between it and the back head in order to prevent radiation as far as possible. The fire-brick is made entirely of one piece, as all ordinary constructions would not be able to withstand the great heat.

6. The water gauge has a special independent connection with the steam space of the boiler, so that its operation is not influenced in the slightest by the working of the injectors.

7. The tubes, which have an outside diameter of 1.8 in., are spaced 2.4 in. apart at the front end and 2.5 in. at the back, in order that the generation of steam, which is greatest at the back, may be freer, and there is more water space between the tubes for circulation.

These peculiarities were first embodied in the boilers built by the Hanover railways.

In other respects the flue is straight and horizontal, and the shell of the boiler is made of as few sheets as possible. The riveting of the horizontal seams is made with double welts and four rows of rivets. The longitudinal section of the boiler, which is given in our illustration, shows that the double grates are likewise made of one piece throughout their whole length, in order to facilitate the clearing out of the air spaces from beneath. The latter support of the grates on the flue is made with cast iron bars which lay in the corrugations of the flue and are held on the sides by being screwed to angle pieces.

Construction.—The sheets are made of open-hearth steel and the specifications for their manufacture and manipulation are the same, as has already been given for our ordinary boilers with steel fire-boxes. These flue boilers are being built to replace the old boilers that are wearing out. The expense of construction with grates and water gauges is 10 per cent. less than for boilers of the same capacity with copper fire-boxes and without grates and water gauges.

Handling in Service.—The only instructions which were given for handling these boilers in service were that the trap beneath the bridge wall and the back head of the flue should be carefully kept as tight as possible in order to avoid entrance of cold air into the ashpit. In cleaning out the cinder chamber before the trap is opened, the top of the stack must be closed with a sheet of metal so that the cold air may be prevented from passing through and striking against the hot tubes. On March 1 we had constructed and put in service these flue boilers as follows: One in February, 1891; one in March, 1891; two in December, 1892; one in January, 1893; one in February, 1893.

Four boilers are now already constructed and will be put in service in a short time. Fifteen are under contemplation and will probably be started during the year.

Results in Service.—After placing the two first locomotives in service, various troubles were developed which at first could only be observed upon the ground and after careful attention. Evaporation was insufficient because the exhaust pipe stood very high in consequence of the unsuitable form of the stack, producing an insufficient vacuum in the smoke-box. After these difficulties and other changes in the stack and blast-pipe had been effected, an analysis of the gases and a measurement of the temperature in the smoke-box was made. It was practically the same as in a locomotive, doing the same service with the ordinary fire-box and having a brick arch, and was as follows:

There was no difference in the combustion as far as thoroughness went, in the engines, and the amount of carbonic acid gas and the excess of oxygen was alike in both boilers.

The heat of the gas in the smoke-box averaged from 608° F. to 654° F. in the flue boiler, and from 518° F. to 572° F. in the ordinary boiler; thus the first was from 70° F. to 90° F. higher, which was evidently a result of its smaller heating surface. As for the difference in the heat of the gases at the top and bottom rows of tubes in the flue boiler, it was evident that the height of the blast pipe to the contracted portion of the stack had a great influence. At first the difference in the temperature was from 5° F. to 50° F. higher at the top than at the bottom; by raising the blast tube about 2.6 in. the difference was raised to from 68° F. to 108° F., and dropped when the blast-pipe was lowered below the first row of tubes to from 68° F. to 0° F. In the locomotive with the ordinary fire box the gases at the top row of tubes was from 18° F. to 35° F. hotter than at the lower. These results show that an average specimen of gas taken midway between the top and bottom row of tubes, with a suitable height of blast-pipe relatively to the stack, can also be obtained without making use of any special appliances, such as a brick arch over the bridge wall or deflection plate in the smoke-box.

Unequal drafts of the products of combustion through the

tubes also caused an uneven burning of the fire on the grates, a high position of the blast-pipe causing a rapid combustion at the front end of the grates and a weak combustion at the back, while, when the blast-pipe was low, the reverse was the case. These observations were also made on many other locomotives. The following table gives the results:

Position of the Blast Pipe Relatively to the Stack.	Draft of Gas through the Tubes.	Combustion in the Fire-box.
High.	Top.	Front.
Medium.	Even.	Even.
Low.	Bottom.	Back.

The proper position generally seems to be that in which the position of the blast-pipe relatively to the contracted portion of the stack is such that the top of the blast-pipe is three times the smallest diameter of the stack below it, and this is shown to be the proper place by a careful observation of the fire when testing the temperature of the smoke-box. This low position of the blast-pipe works just as well with the flue boiler as with the other in causing a rapid evaporation and ebullition of the water in the boiler. It is difficult to explain in what way this action is interdependent. It would be interesting and valuable to investigate as to what the results of experience have been in other places.

The leaking of the tubes in both of the original boilers was at first very considerable, because the traps beneath the bridge walls could not be kept tight and cold air would get through. These traps were for the purpose of protecting the high temperature in the bottom of the combustion chamber, where the cinders gathered, as much as possible, and these lay up against it so that it was frequently covered with red-hot ashes and was consequently warped and made loose by the heat. In order to avoid this, the traps in one of the locomotives was lined with fire-brick, whereupon the leaking ceased, showing that it was only necessary to get at the cause in order to stop the trouble with leaking; then an order was given that the cinder space should be cleaned out at the end of every run by a workman crawling in over the grates, so that the locomotive should be as free from trouble in this respect as possible.

In boilers which were afterward constructed the trap was made larger and stronger, and so placed beneath the bridge wall that it was easily kept free of ashes. These traps have given very good results up to this time, and are not visibly warm even when the locomotive is working its hardest. Only upon the sides of the framing next the trap is there the slightest semblance of a dark red color. Both of the original boilers have also been lined with the best of fire-brick.

The back head of the fire-box must have the space between it and the corrugations of the flue well filled with fire clay made thick and thoroughly bedded in, in order that no cold air may enter through these spaces.

In the new boilers the tubes are fastened into the forward tube sheet on the American system with soldered copper ferrules .04 in. thick. In spite of this these boilers have several times given trouble with leaky tubes, which has, nevertheless, been attributed to the inadequate working of the blast in connection with bad feed-water and careless handling. By getting the blast-pipe into a proper location the tubes remained tight very much better, and will evidently have as long a life as those in the copper fire-box, since they can be fastened more securely in the steel sheets. When necessary the tubes can be screwed into the back sheets, as is frequently done in marine boilers, since their removal gives them a greater or less degree of inconvenience. Also a very fine thread could be cut in the hole in the sheet by means of which the ends of the tubes could be drawn back by turning them around. I hope that these difficulties will be overcome in a very short time.

The skill in firing on the inclined grates is very soon obtained by the fireman. Coal must be thrown into the fire-box more frequently than with the fire-box having a deep space over the grates, since the fire can only be maintained at a depth of from 10 in. to 12 in. For coal that burns with difficulty the heating surface must therefore be kept as large as possible, and care must be taken that coal is not thrown over the bridge wall. The fire-brick must also be built up again as soon as it is burned away to any degree.

The coal consumption, in spite of the smaller heating surface on these engines, the action of whose blast pipe was not altogether satisfactory, was not essentially greater than those with the ordinary fire-box, so that the evaporative efficiency of the flue boiler was considerably higher, and with an equal heating surface and the same steam pressure there should be no difference in the consumption of coal. The water may be kept at a high level in the boiler without any danger of particles being entrained into the cylinders. The time consumed in getting up steam in these boilers was about the same as with the others.

Cleaning out of the cinder space, which was made at the home station at the end of each run, is done by means of a scraper on a long handle made of gas-pipe. The trap is pushed open and held in position by a suitable strut with a long handle. The tubes are cleaned with a scraper at the end of a long handle. It is especially desirable that this work should be accomplished without there being any necessity for having a man crawl over the top of the grates, since the latter are very frequently hot, and the locomotive would have to be cooled off before the work could be done, which would necessitate its being out of service longer than desirable.

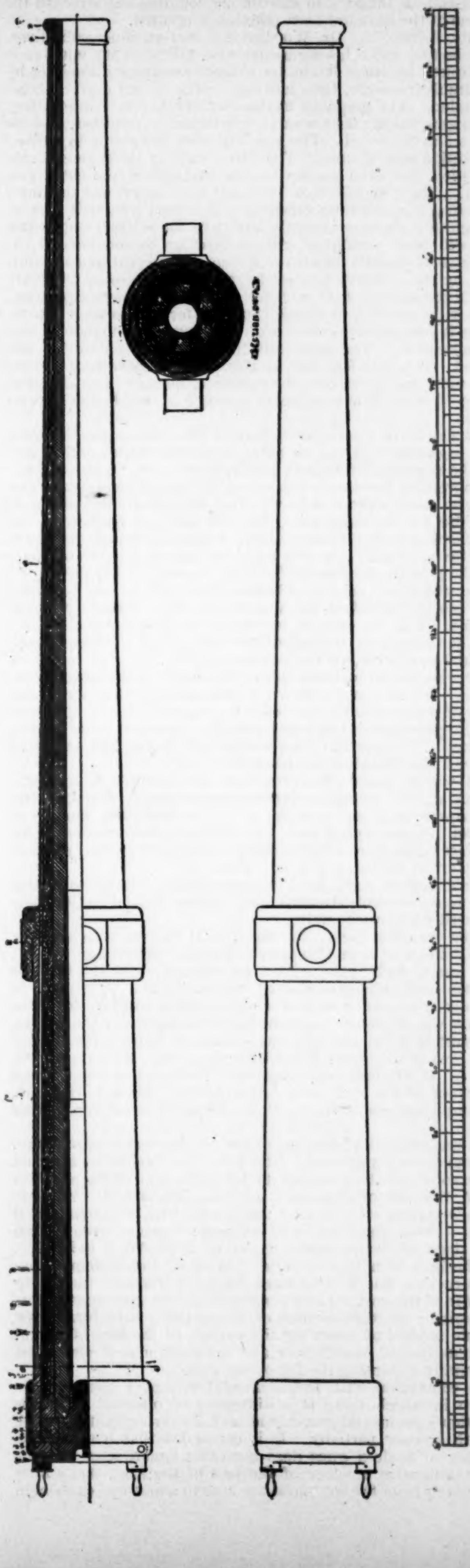
Maintenance of Boiler.—Beyond the repairs due to leaky tubes and the two transverse pieces on the lower portion of the cone-shaped ring, which were more or less leaky at the beginning, and the trouble with the burning out of the fire-brick, both of the original boilers having been in service for a space of two years, and do not as yet show any necessity for overhauling. The flues, as far as they can be inspected with lamps and reflectors through the hand-hole openings, seem to be perfectly uninjured on the lower side, although there is a slight coating of scale over them. On the inside beneath the grates there is a hard mass which consists of the salts of the ashes bedded into the corrugations, but it only contains a very slight amount of iron rust. There is very little iron rust to be detected on the inside. It would seem, therefore, that these flues are in a fair way to give a very considerable length of life; but even if these further expectations are not fulfilled, and it should be necessary to renew them, it is a matter of no great difficulty, for the renewal of the flue would be very easy and would not occupy more than eight days at the outside.

The great expense which very frequently results from necessities for repairs on the ordinary fire-box, and the placing of the locomotive out of service in consequence thereof, will be avoided in the case of the flue boilers. The repairing of the other parts would be far simpler and easier, since we would not be so entirely dependent upon the capacities of our boiler shops. The accounts will show that there will be a saving of about 25 per cent. in repairs, or 5 per cent. of the total cost of the locomotive, and this can be reckoned as about 10 per cent. of the expense of repairs; for a locomotive costing $10,000, which makes an annual run of 24,850 miles, and expense for repairs and renewals will amount to about $50 per 1,000 miles; thus we have the following yearly account:

5 per cent. of $10,000	$50.00
Repairs, 24,850 miles at $50 per 1,000 miles	124.25
Total	$174.25

Therefore we have a corresponding saving in shop space. For a large road with 1,000 locomotives there would be a yearly saving of $174,250, a sum which is certainly worth looking after, and would seem to warrant especial attention toward the application of these flue boilers. If the results of experiments with flue boilers on other roads do not appear to be so satisfactory, the troubles which arise should be attributed to construction and handling. As in most other innovations, it is not sufficient that the boiler should be simply constructed and put into service in order that it may give good results. There are many things which will come up with any good thing which is new, whereby troubles will appear at first which can be easily overcome by careful attention. At first a watchful eye must be kept on all parts, for deficiencies will soon put in an appearance, and these must be met by careful personal attention. When the new device has been freed from its original defects and confidence has been obtained in the *personnel* of the men who have charge of it, it then remains for it to show whether it will meet expectations in the daily service, and whether these defects will grow.

I am thoroughly convinced that with careful handling the flue boiler is an innovation of the utmost importance. It readily lends itself to a rearrangement of the frames, so that in three-coupled freight engines a wheel-base of 13 ft. can be very readily obtained, which will permit of the speed of 25 miles per hour or more being maintained, and the frames can also be brought nearer together, so that room is secured for large cylinders, bogie trucks, and radial axles. The flue boiler is especially suitable for compound locomotives, since it can be used with a higher steam pressure, amounting to as much as 180 lbs. per square inch, with perfect safety.



SECTIONS AND SIDE ELEVATION OF THE BROWN WIRE-WOUND GUN.

THE BROWN WIRE-WOUND GUN.

THE Brown wire gun, says the *Journal of the United States Artillery*, consists essentially of a segmental core wound with wire, under such tension that the compression between the longitudinal segments of the core induced thereby will be more than sufficient to resist all ordinary powder pressure.

The longitudinal segments are primarily held together by a breech and muzzle nut, screwed on hot, with the proper degree of shrinkage, so that the tension of the nut and adjoining wire will be the same after winding.

The wire is wound between the nuts under a high degree of tension and anchored by a special device.

The trunnions are not attached to the core or body of the gun, but to an outer trunnion jacket, which jacket is attached to the gun proper by means of the breech nut. The breech block engages in a bushing which is screwed into the trunnion jacket. By this means the recoil is transmitted to the trunnions through the bushing and jacket; and the core or body of the gun is thus relieved from the major part of the longitudinal thrust due to powder pressure upon the bottom of the bore. The gun itself is free to expand longitudinally within this jacket, which is attached only to the breech nut.

The engraving shows a longitudinal section of the gun, and also a cross-section through the powder chamber, as well as the general contour.

The *modern system* of gun construction consists essentially of a core or body which is placed under a condition of "*initial compression*," by means of outer jackets of some kind; which are either shrunk on, as in the case of "*built up guns*" or wound on under tension, as in the case of "*wire guns*."

This "initial compression" produces in the core or body a circumferential compression, which is a maximum at the surface of the bore.

The action of the gunpowder is first to overcome the circumferential compression at the surface of the bore, and then to stretch the inner core or tube.

The action of the gunpowder is first to stretch the outer jacket, and compress the metal of the core, and after the initial compression has been overcome to stretch the core or inner tube, at the same time increasing the compression.

If the powder pressure is of such magnitude, that either the outer jacket, or core, is stretched beyond its elastic limit of extension, or the inner tube compressed beyond its elastic limit of compression at the surface of the bore, a permanent set will be given to the metal at some point; and on being released from the powder pressure, the gun *will not* return to its original condition and dimension. If neither of these limits are exceeded, the gun will return to its condition before firing, when relieved of pressure.

Many attempts have been made to use wire for the outer jacket of guns. In this connection, however, there is one serious difficulty to be overcome. A solid outer jacket has longitudinal strength; whereas a wire jacket of itself has none. Now the area of cross-section of the core or body of a properly constructed wire gun is about one-half of that of a solid "built up gun" of the same dimension; and about two-thirds of the thickness of the metal of a large "built up gun" can be utilized for longitudinal strength. The entire core of a wire gun, being in one piece, can be so utilized. Therefore, where the metal of the core or body of a wire gun has the same elastic strength as the metal of the "built up gun," the longitudinal strength of the wire gun is but three-fourths of that of the "built up gun."

Mr. Brown undertakes to solve the problem of longitudinal strength by increasing the elastic strength of the *core itself*. He *sub-divides the core or body* of his gun into *longitudinal segments* of such a size that a high condition of *special elasticity* may be set up therein and the requisite longitudinal strength be thus obtained.

By this process he can, without difficulty, *double* the elastic strength of the metal used in the core of his gun, still retaining sufficient ductility: and, therefore, although the area of cross-section of the core of his gun is but one-half of that of a solid "built up gun," the gun will have one and one-half times the longitudinal strength, as the metal has double the elastic strength of that used in the "built up gun."

But in order to do this does he not sacrifice the circumferential elastic limit for extension of his core? True, but as at the same time he can double the elastic limit for compression of the metal he can wind with twice the tension; and, therefore, double the initial compression at the surface of the bore.

In any gun the maximum safe value of the powder pressure must not exceed about 63 per cent. of the compression plus the elastic limit for extension, nor 94 per cent. of the elastic limit for compression. In order to determine the maximum safe powder pressure, we must determine which is the least of

these two values. The above figures are for a gun in which the minimum thickness of metal over the maximum powder pressure is one caliber.

For steel we may consider the two elastic limits as equal. In all guns the compression is made equal to the elastic limit.

In built up guns, therefore, the two values are 63 per cent. of twice the compression and 94 per cent. of the compression. Of course, the latter is the smaller, and therefore the maximum safe value of powder pressure.

In the Brown segmental wire gun the core has no elastic strength for circumferential extension; the two values are 63 per cent. of the compression and 94 per cent. of compression: the former is, of course, the smaller value. If, however, we can double the elastic limit, we can use double the compression, and therefore the maximum safe value of the powder pressure for Brown segmental wire gun will be to that of the built up gun as 126 is to 94.

We will now show that the claim that the segmental tube can be constructed of a steel having twice the elastic limit of that used in built up guns is entirely within the actual results obtained.

The physical conditions demanded by the Government for seacoast guns is shown by the following tables, taken from the report of the Chief of Ordnance of 1889, page 254, being a part of the specifications for steel forgings for 8, 10, and 12-in. guns, under Act of September 22, 1888.

These tables undoubtedly show the best conditions obtainable in large forgings from open-hearth steel. Table I. gives dimensions of specimens.

TABLE I.

"Each of the test specimens should show physical qualities given in the following table, No. I., which the manufacturer should aim to obtain."

CALIBER OF CANNON.	Designation of Pieces.	Elastic Limit. Lbs. per sq. in.	Tensile Strength. Lbs per sq. in.	Elongation after Rupture.
Seacoast, 8 in.	Tube.	46,000	86,000	19 per cent.
	Jacket.	50,000	93,000	17 "
Seacoast, 10 in., and over	Tube.	46,000	86,000	19 "
	Jacket.	48,000	90 000	17 "

TABLE II.

"The forgings shall, however, be accepted as to physical qualities, provided no one of the specimens shows results in any particular below the figures given in the following table, No. II."

CALIBER OF CANNON.	Designation of Pieces.	Elastic Limit. Lbs. per sq in.	Tensile Strength. Lbs. per sq. in.	Elongation after Rupture.
Seacoast, 8 in.	Tube.	42,000	78,000	17 per cent.
	Jacket.	46,000	85,000	16 "
Seacoast, 10 in. and over	Tube.	42,000	78,000	17 "
	Jacket.	44,000	83,000	16 "

To distort the segmental tube of the 5-in. Brown gun would require a pressure of 94,000 lbs. per square inch, being beyond the possibilities of gunpowder. To distort the lining tube will require a pressure equal to 94 per cent. of its elastic limit. The probable elastic limit obtainable in lining tubes will be discussed farther on. However, as it is hardly probable that a breech mechanism will ever be devised, a carriage ever constructed, or a projectile ever be forged which will stand 60,000 lbs. pressure per square inch, it is waste of time to discuss these excessive theoretical pressures.

Longitudinal stress in a gun may be divided into two parts: that which is due to the pressure upon the bottom of the bore, and that which is due to the radial compression of the inner tube between the powder gas and the outer jacket.

In the Brown system the former is transmitted to the trunnion jacket through the breech nut, the trunnions being in no way attached to the segmental tube (see engraving). The segmental tube being required to take up only that longitudinal thrust due to compression between the powder gas and wire jacket plus that due to friction of the shot in the bore. Furthermore, as the trunnion jacket does not touch the segmental tube nor even the wire, and as there is a slip joint between it and the chase jacket, none of the thrust taken up by the jacket is transmitted to the segmental tube by friction. It must be remembered that as the liner in the Brown gun is in two or more pieces, and is not attached in any manner to the breech mechanism, it can do but little toward resisting longitudinal thrust. In calculating longitudinal strength the value of the liner has been practically ignored.

Mr. Brown, like Dr. Woodbridge, uses an inner solid liner, but he first winds his segmental core, and after the winding is complete he bores it out on a taper and inserts the liner by hydraulic pressure, thus insuring a true fit and uniform compression. The proposed method will probably be interesting. The gun, having been wound, will be bored to caliber, and the breech action fitted. The gun will then be *fired* in its unlined condition several shots. The firing will jar the segments into position, and even up the tension throughout the entire system. The gun will then be bored on a taper, and the liners inserted by hydraulic pressure. The lined gun will then be bored to a diameter slightly less than the caliber, and in this smooth bore condition will be fired up to and beyond the *maximum pressure* which the system is expected to stand during action. Heavy projectiles will be used so as to obtain high pressures. This will not only set the liner in position, but will determine its elastic condition for compression; therefore it cannot thereafter take a permanent set under a less compression. The gun will then be bored to caliber and rifled. It is manifest that by this process a condition of compression and fit between the various elements will be obtained, as perfect as it is possible to produce by mechanical operations.

It should be remembered that as the compression between the segments will not be reduced to zero during action, and as the segmental tube acts precisely as a solid tube until this compression is reduced to zero, the Brown segmental wire gun can be used without a liner. This was clearly demonstrated by the two cylinder tests, in their unlined condition. In neither case was there any radial or longitudinal displacement of the segments, nor was there any increase in the diameter of the powder chamber under high pressure. The only question which can arise, is whether there will be any tendency for scoring to follow the line of the joints between the segments. This can only be determined by actual test.

The theoretical circumferential strength of the 5-in. experimental gun is 100,000 lbs. per square inch.

It was desired to make this compression at the surface constant: but it can be shown mathematically that a constant rate of compression from breech to muzzle is not possible with a straight tapered core and a straight tapered exterior of wire jacket. The constant compression was thererefore sacrificed to ease of mechanical construction.

It will be noted, however, that the variation is comparatively slight. Being a maximum at the breech of 100,000 lbs. per square inch, and a minimum 50 in. from the muzzle of 96,000 lbs. per square inch, the minimum compression at the surface of the bore affected by the maximum powder pressure is about 99,800 lbs. per square inch.

Calculations made for a uniform tension clearly show that the wire has ample strength, and that the simpler method may be used with entire safety.

The trunnion jacket for the 5-in. B. L. rifle was made by the Bethlehem Iron Company. Tensile strength, 92,409 lbs. per square inch; elastic limit for extension, 49,916 lbs. per square inch; elongation after rupture in 2-in. specimen, 24 per cent.; minimum area of cross-section is 55.26 sq. in. The jacket will therefore stand, without taking a permanent set, a thrust of 2,758,238 lbs., and without rupture 5,160,337 lbs. The area of the breech-block is 21.65 sq. in. A powder pressure of 53,000 lbs. per square inch will give a longitudinal thrust of $53,000 \times 21.65 = 1,169,100$ lbs. There is therefore an ample margin of safety, with a factor of safety for rupture of 4.4.

It was originally intended to use an *increasing twist* curve, a semi-cubical parabola. The late experiments in England seem so clearly to demonstrate the advantage of the *uniform twist*, that the original idea has been abandoned. A polygroove system will be used: *uniform twist*, 24 grooves and lands; twist, one turn in 25 calibers; depth of groove, 0.05 in.; shape of groove similar to that of U. S. Army 10 in. rifle.

The liner is not an essential feature of this system of gun construction, but is introduced for the purpose of increasing the life of the gun. The *bete noir* of modern gun constructors is scoring; and the insertion of a thin lining tube furnishes a simple method of renewing the surface of the bore of a gun, by removing a scored liner and inserting a new one; thus materially increasing the life of the gun.

In connection with the segmental system a question has arisen in which there is a difference of opinion. That is whether a segmental gun should be lined throughout its entire length or only partially. It is contended that inasmuch as scoring in modern guns does not extend more than three or four calibers in advance of the seat of the shot, that a liner extending from the bottom of the bore to about five calibers in

advance of the powder chamber will be sufficient. On the other hand, it is contended that a segmental tube is more likely to score than a solid tube, there being a tendency to follow the lines of juncture; and therefore that it would be wise to line from breech to muzzle. It is further contended that the tendency to score will be increased by rifling the segmental core.

The 1-in. model gun was unlined and rifled, was fired under very high pressures, and no scoring was noticed, save at the *seat of the shot.* The gun, however, was not fired a great number of times.

Cylinder No. 2 when fired in its unlined condition showed a tendency to score along the lines of juncture after a pressures of 43,000 lbs. per square inch was reached. The reply to this fact is, that the unlined portion of the gun would never be subjected to such pressures. The problem can only be solved by actual test. At the present writing it is Mr. Brown's intention to line partially and to test the gun under high pressures; if scoring begins in the unlined bore, then to line from breech to muzzle.

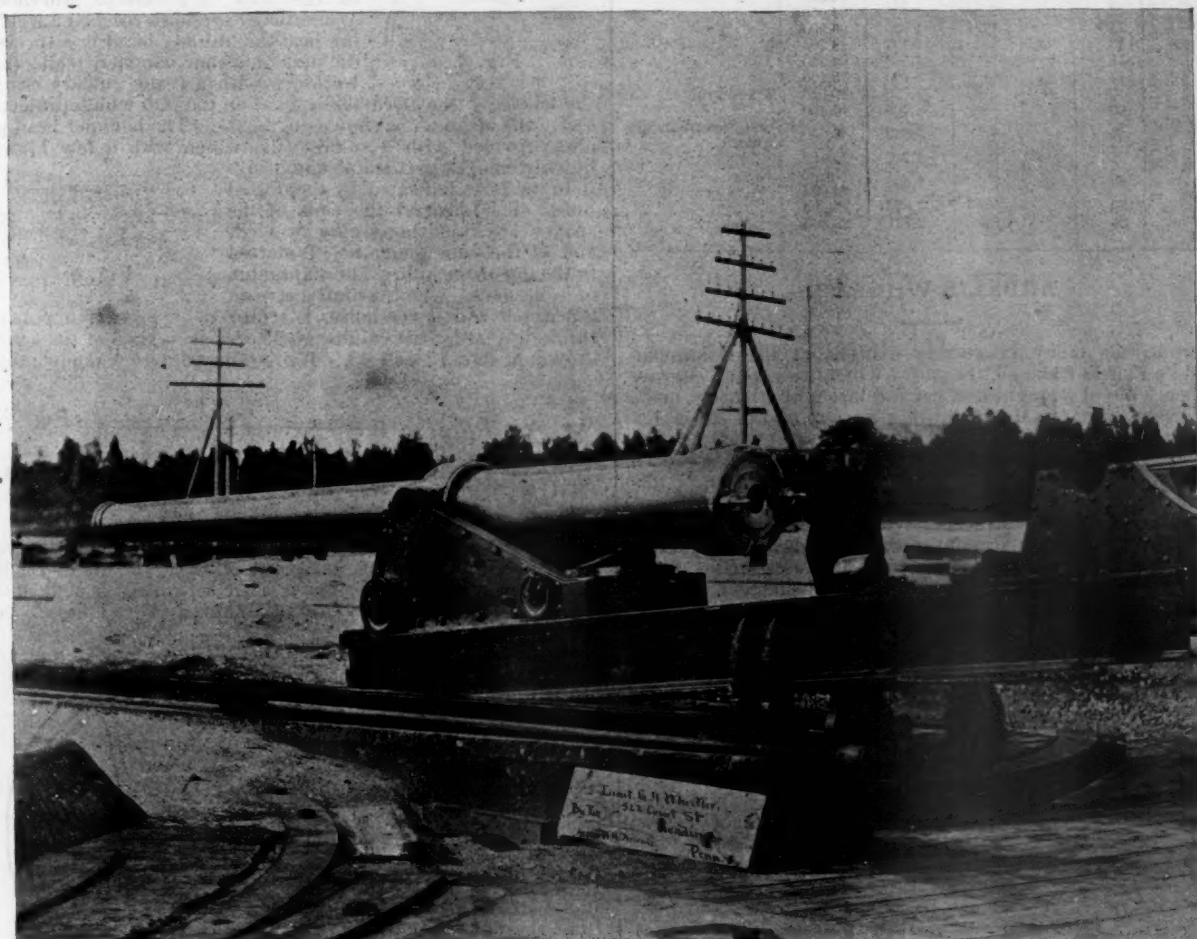
sion of the liner; if, however, a liner can be constructed of crucible chrome steel having an elastic strength of 100,000 lbs. per square inch, the stresses in the liner will not pass through zero during the maximum action.

CONCLUSION.

The advantages claimed for the system are as follows:

First By the longitudinal subdivision of the core, crucible steel can be used economically. Chrome steel can be used. A more perfect tempering is possible than in large solid tubes. A more careful and accurate inspection is possible. Small blow-holes will be reduced in diameter by the forging and rolling process, and can affect only the strength of a single segment. A higher condition of special elasticity can be set up in the metal than is possible in large masses. The maximum longitudinal strength obtainable from steel can be ensured by this process of construction.

Second. A higher initial compression can be given to the core or body of the gun, admitting of the use of higher powder pressure than is possible in the built-up system.



THE BROWN WIRE-WOUND GUN AS MOUNTED AT SANDY HOOK.

While it is impracticable to obtain large cylinders of much over 50,000 lbs. per square inch elastic limit, it is entirely practicable to obtain thin liners not over 1 in. thick, with very much higher elastic conditions.

The Bethlehem Iron Company have agreed to furnish a liner for the 5-in. experimental gun, with the following conditions:

Tensile strength, 105,000 lbs. per square inch.
Elastic limit, 60,000 lbs. per square inch.
Elongation in 2-in. specimens 15 per cent.

Such a liner inserted with a maximum tension will readily sustain a pressure of more than 50,000 lbs. per square inch without being overstrained.

If the liner be divided into two parts, the breech liner could be made of crucible chrome steel, and the chase liner of open-hearth steel, which would give ample elastic strength for the entire length of liner.

If a liner of 60,000 lbs. per square inch is used, it will, of course, be necessary to utilize the elastic strength for exten-

Third. In the Brown system the maximum strength of each portion of the gun is in the direction of the maximum stress it is called upon to bear. Neither in the core nor wire jacket does the condition of stress ever pass through zero during maximum action.

Fourth. A segmental gun can be constructed more economically than any other gun of equal power. The expense of casting, forging, and rolling the segments is much less than for large solid tubes. There is practically no risk of loss, as should a segment fail after treatment to show the necessary elastic strength, it can readily be rolled into commercial steel. The amount of machining is not greater than in a built up. The expense of winding is very small as compared with that of shrinking on jackets.

Fifth. The form, method of construction, and high power of the Brown segmental wire gun insures a greater muzzle energy per ton of weight than it is possible to obtain by any other system of gun construction now known.

Sixth. In the case of a sudden emergency the Brown guns

can be constructed in any machine shop having a lathe of sufficient length to receive the gun.

In order to give our readers an idea of what has been actually accomplished in the firing of the Brown gun at Sandy Hook, we append a record of the firings that were made by the officials of the Government with the apparatus installed at that point.

REPORT OF FIRING WITH 5 IN. B. S. W. RIFLE NO. 1, AT. U. S. PROVING STATION AT SANDY HOOK, ON AUGUST 18, 1893.

No. of Fire.	Powder.		Projectile.		Instrumental Velocity at 250 ft. from the Muzzle. ft. sec.	Pressure in Bore. Lbs. per sq. in.	Remarks.
	Kind.	Weight. Lbs.	Kind.	Weight. Lbs.			
86	Leonard Smokeless Ruby, N. C., Long Grain. Du Pont's Brown Prismatic.	7	Steel.	62	1,694	20,200	Short grains.
88		7.25			1,690	19,100	
90		9			1,841	under 24,000	
91		11			1,965	20,900	
93		13			2,197	28,700	
95		15			2,368	32,850	
96		17			2,490	35,100	
97		19			2,770	46.550	Mixed grains.
98		20			2,768	46,400	
99		21			2,839	46,800	est record in the world.
87		25			1,712	Lost.	
89		25			1,692	Under 24,000	
92		30			1,870	23,300	
94		35			2,021	29,600	

ARBEL'S WHEELS.

Among the many interesting exhibits at the Columbian World's Fair in Chicago, the one of which we give an engraving herewith, of wrought iron car and locomotive wheels, made by the Anonymous Manufacturing Society of the Arbel Establishments, from Rive de Gier, France, is well worthy of the study of American railroad men. This company has issued a descriptive pamphlet of their exhibit, which contains an historical account of the evolution of wrought-iron railroad wheels, of which we have made very free use in the preparation of the following account of the methods of manufacturing such wheels which have heretofore been used, and of those which are now employed in the Arbel establishments.

Fig. 1.

In the early days of railroading, car and locomotive wheels were made in Europe of a combination of wrought and cast-iron parts. The spokes and the rims of the wheels were made of wrought iron and the hubs of cast iron. The process of manufacture may be described as follows: The spokes were made of wrought iron bent into the form shown by figs. 1 and 4. They were then assembled in a mold in the relation to each other which they were intended to occupy in the wheel, as shown in figs. 2 and 5. Melted cast iron was then poured into a suitable cavity at the center, which thus formed the hub. This hub when it was cast surrounded the ends of the spokes in a length of from 3 to 5 in., and held them in their position. The spokes were formed of various shapes, and parts of the bars from which the spokes were made formed the elements of the rims, as will be apparent from figs. 1, 2, 4 and 5. The spokes were either riveted together, as shown in fig. 5, or in wheels like that shown in fig. 2; triangular pieces were fitted in where the elements of the rims joined each other, as indicated by the shaded areas in fig. 12, and they were then heated and welded at these points.

Fig. 2.

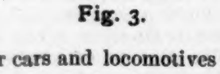


Fig. 3.

These wheels had very little strength, as the spokes and the rivets often worked loose. The exclusive use of wrought iron was a consequence of these defects, and of the use of heavier cars and locomotives and greater speed.

Before steam hammers were as generally used as they are now wrought-iron wheels were made by the following processes: 1. The spokes were first prepared by binding a piece of iron, as has been described. Sometimes these elements were made to form part of the hub as well as of the rim, as will be explained. 2. The hub was prepared to weld to the spokes. 3. The spokes and hub were welded together. 4. The parts of the rim were welded together.

To make these processes clear, it may be said that one form of wheel is made as follows: Pieces of iron of the form shown by figs. 7 and 8 were made in special rolls designed for the purpose. These were then bent into the form shown in fig. 9 in a special screw press. The elements which form the spokes, rim, and part of the hub are then assembled together and held by a suitable clamp, as shown in fig. 10. Distance pieces, shown by the shaded areas near the center of fig. 10, are then driven in between the ends of the spokes which form part of the hub. The assembled parts are then placed on a small circular forge, so that the central part, for a short distance outside the keys, is heated to a white welding heat. At the same time a hub, which has been made of the form shown in section by the shaded area in the middle of fig. 11, is also heated in a furnace to the same temperature as the hub in a suitable furnace. When they have both reached a welding heat the hub is placed in a special die under a steam hammer, while the workmen with a crane quickly bring the whole of the assembled spokes on the hub which projects above the opening, as shown in fig. 11. The hammer-head is also provided with a suitable die which with a few blows quickly compresses the hub and brings it to the form indicated by the dotted lines. The hub and the ends of the spokes are thus thoroughly welded, and at the same time a hole is started in the top of the hub. The diaphragm of solid metal, which is left between the upper and lower holes, is removed by driving a punch through it under the hammer. The wheel is then of the form shown in figs. 12 and 13. Wedge-shaped pieces, shown by the shaded areas in fig. 12, are then inserted in the spaces when the bent "forms" join each other at the rim. Each one of these junction points is then separately heated and welded. These processes are still extensively employed in England and Germany.

Fig. 4.

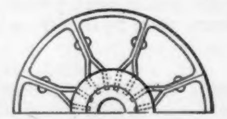


Fig. 5.

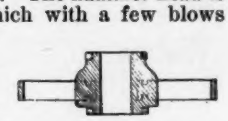


Fig. 6.

Fig. 9.

Fig. 7.

Fig. 8.

Figs. 14, 15, 16 and 17 show a similar method of making a wheel of somewhat different form. The method of manufacture will be apparent from the engravings without further description. In the form of wheel shown in fig. 15, the wedge-shaped pieces are inserted from the top and bottom instead of from the outside of the periphery of the rim at the points where the rim is welded together.

Fig. 10.

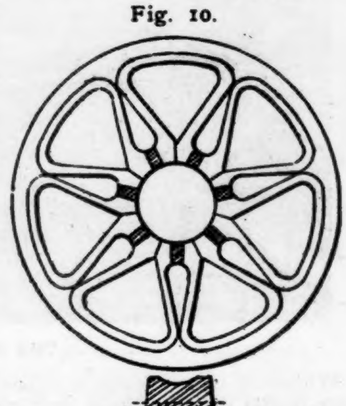


Fig. 11.

Still another method is shown in figs. 18–22. A hub shown in fig. 18 is first forged with short projections, which are intended for rudimentary spokes. T-shaped pieces, shown in figs. 19 and 20, are then made, the vertical part of which forms the spoke and the horizontal portion the rim. These are then assembled and held in a suitable clamp, as shown in fig. 21, and a separate heat and separate weld is made for each junction of the spokes and rim. The whole of this work may be done by hand and without the aid of a steam hammer.

ONE-PIECE WROUGHT-IRON WHEELS.

At the Arbel Works wheels are made by stamping under a hammer a wheel which has been thoroughly heated, all the

parts of which have previously been fitted together cold. The process of manufacture for car-wheels is as follows :

Fig. 12.

Fig. 13.

A bar of suitable section is bent in rolls to form the rim. This ring of metal is then held in a clamp provided with screws, as shown in figs. 23 and 24, the unwelded ends of the bar abutting together. It is then placed in a fire and the ends heated to a welding heat. By turning the screw the ends are then pressed together, and only a few blows are needed thereafter to make a perfect weld.

Grooves are then cut by a special machine in the inside of the rim to receive the ends of the spokes, as shown in fig. 25. The spokes are formed of bars which have been rolled to an elliptical shaped section, and are upset in dies at their outer and inner ends, where they are welded to the rim and hub.

Fig. 14.

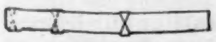


Fig. 15.

The hub is made in two halves, as shown in section in fig. 26, the upper and lower portions being separate. These are made from a rectangular rolled iron bar, which is heated to a white welding heat, and then bent under a steam hammer around a conic mandrel with special dies. It is then reheated and put between two dies, one fitted to the hammer and having suitable cutters, the other fitted to the anvil and having cavities corresponding to the cutters. By this means grooves are cut in the periphery of the hub to receive the spokes. The spokes, the rim, and the hub are then assembled, as shown in figs. 25 and 26. An important feature in this making up is the "dish" which is given to the wheel, which must always be greater than that necessary for the finished wheel, and which gives sufficient stability to the assembled parts to enable them to be handled and insures a perfect welding of the spokes and rim by the compression which occurs in the direction of the spokes during the stamping of the wheel. In order to obtain a good forging, the width of the "shapes" of wrought iron are also made greater than that of the finished rim and spokes, so that in the process of stamping the metal is compressed and condensed.

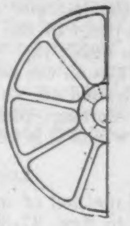


Fig. 16.

Fig. 17.

To weld the parts of the wheel together, it is taken up by a pair of tongs suspended from a traveling trolley, and is placed in a furnace. If it were heated in an ordinary furnace, the lighter parts would be destroyed before the heavier masses were thoroughly heated. To avoid this a special form of furnace, in which the heat is not transmitted by direct contact of the flames to the wheel, but by reverberation, has been devised. The maximum intensity of heat in this furnace is at the center of an arch—that is to say, on the hub, the heaviest part of the wheel. In this way the heat is transmitted to the wheel, so that all its parts are gradually and regularly heated and brought simultaneously to a welding heat.

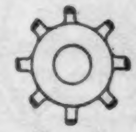


Fig. 18.

Fig. 19.

Fig. 20.

When the wheel has been uniformly heated to a white welding temperature, it is taken again with the same pair of tongs

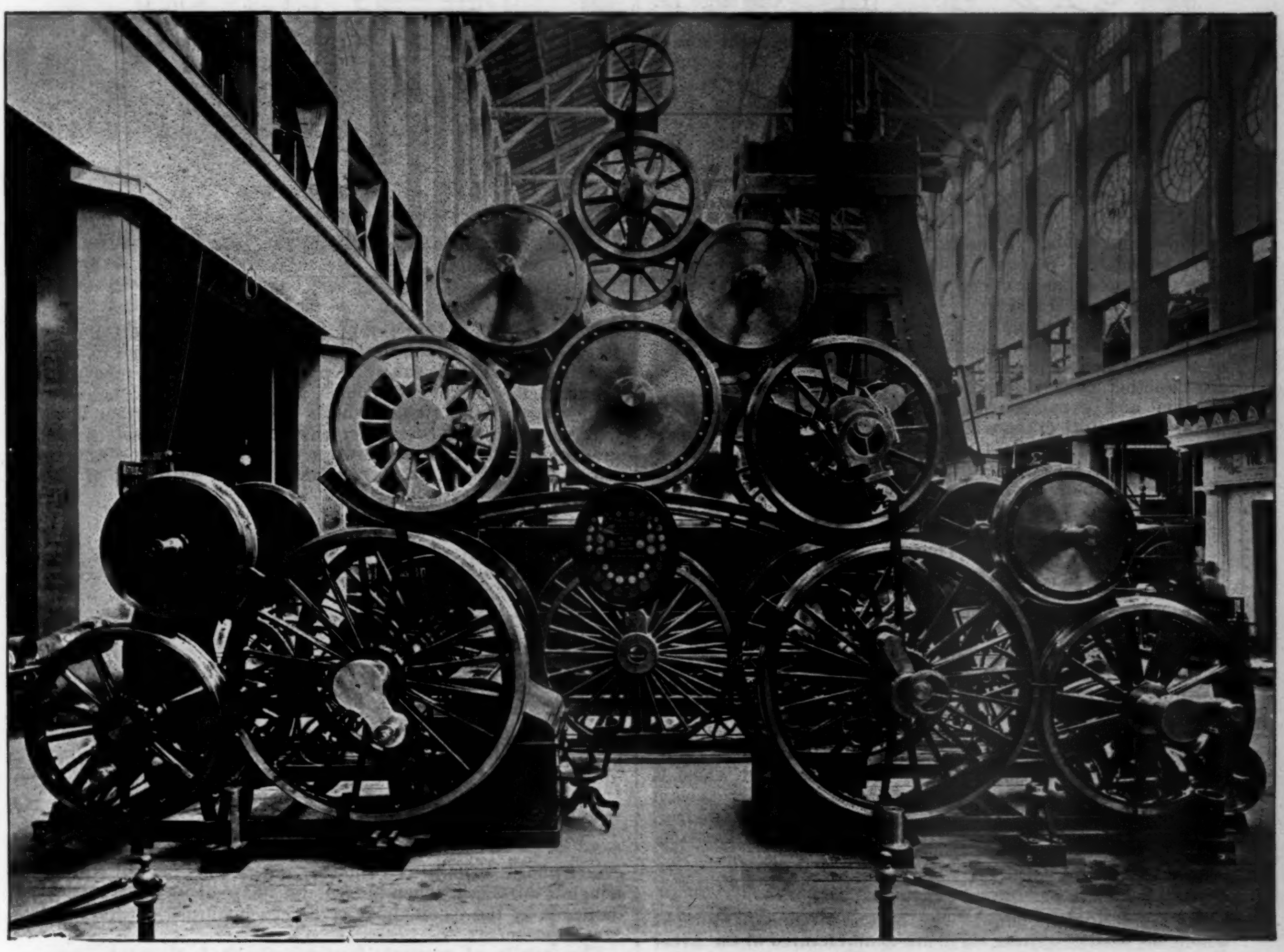


EXHIBIT AT CHICAGO OF THE ARBEL'S ESTABLISHMENTS, RIVE DE GIER, FRANCE.

and put in a die attached to the anvil of a steam hammer. This die forms a mold for one-half of the wheel, and another die, fastened to the hammer, forms the other half. A few blows of the hammer are sufficient to give a perfect welding of all the parts of the wheel. A second and similar heating is given to finish it. When the wheel leaves the hammer the dies leave fins on the wheel where they join each other. These must be cleaned off, and it is then turned and bored. It then passes to slotting, planing, finishing, milling machines and lathes, in which it is finished, and is then ready for delivery.

LOCOMOTIVE WHEELS.

The old method of making wrought-iron locomotive wheels is shown in figs. 27-30. The elements forming the spokes, rim, and part of the hub are made of the form and assembled, as shown in fig. 27. One large element, shown on the right side of fig. 27, is made to form the crank-pin hub and counterweight. The hub is made of a dished shape top and bottom, as shown in fig. 28.

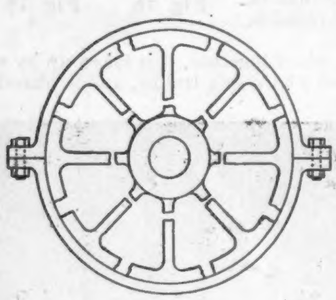


Fig. 21.

Fig. 22.

Washers are welded to the hub, in these dished receptacles, and complete it. Separate welds are made in the rim between each two spokes, as has been explained. The finished wheel is shown in figs. 29 and 30.

This method of manufacture does not require many tools, but is far from being economical, and requires a great number of welds, which, being made one after another, cause unequal contraction and expansion in the metal which subject the wheel to injurious strains.

Fig. 23.

Fig. 24.

To get over these difficulties, the Arbel Company have adopted the following process: The rims are made by the same process as is employed for car-wheels. The spokes are formed by upsetting their two ends and drawing them out under a hammer, so as to reduce their size toward the rim until their shape is like that shown in fig. 31. These parts are then assembled, as represented in the figure last referred to. A pile is then made of suitable size and shape to form the crank-pin and central hubs, and still others to form the counterweight, as shown in the section, fig. 32. The assembled wheel is then heated and stamped between suitable dies under a steam hammer, as has been explained. This process, it is claimed, is much more economical and gives products of incontestable superiority.

VARIOUS TYPES OF WHEELS MADE AT THE ARBEL WORKS.

Besides the spoke-wheels, the process of manufacture of which has been described, there are manufactured at the Arbel Works, and are exhibited in Chicago, wrought-iron plain disk wheels, wrought-iron corrugated disk wheels, wrought-iron plain disk wheel with ribs.

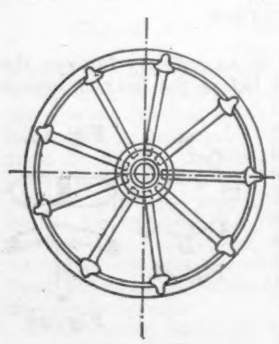


Fig. 25.

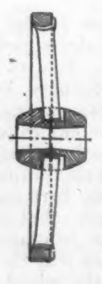


Fig. 26.

The finished spoke-wheel is shown by figs. 35 and 36. Its characteristics are spokes of elliptical section, with a rim which is thicker in the center and of a width nearly equal to that of the tire.

The plain wrought-iron disk wheel, shown by figs. 37 and 38, it is claimed, has the advantage of not raising as much dust as spoke-wheels do. It is said, however, that, owing to the unyielding form of this form of disk, the tires are liable to get loose, and that the disk has but little capacity to resist the end thrust of the axle.

The corrugated disk wheel, figs. 39 and 40, is said to be more elastic than the plain disk wheel, but has even less capacity of resistance to the end thrust of the axle.

Owing to these objections to the two forms of disk wheels, the Arbel Company have brought out a disk ribbed wheel, shown in figs. 41 and 42. This form of wheels was thoroughly tested by M. L. Durant, the assistant of Mr. Ernest Polonceau, Chief Engineer of Machinery and Traction of the

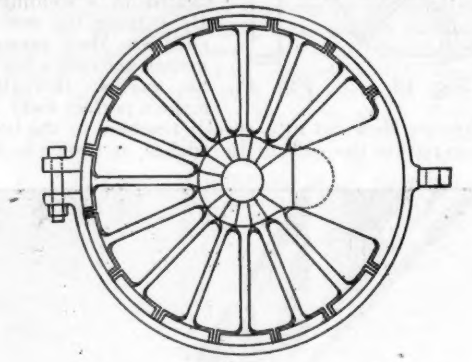


Fig. 27.

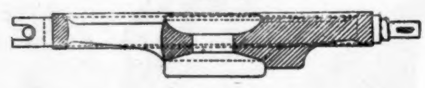


Fig. 28.

Orleans Railway Company of France. A full report of this test is published in the descriptive pamphlet of their exhibit which the Arbel Company have issued. For this report we unfortunately have not room. Mr. Durant, however, concludes that "the ribbed wheels of the Arbel system have marked advantages over other kinds of wheels. It solves to a great extent the problem of suppressing dust during the train's passage; it offers a great resistance to the setting up of the

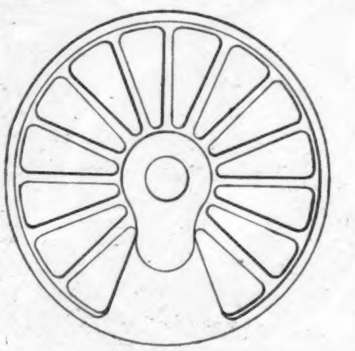


Fig. 29.

Fig. 30.

center of the axle, to the shoeing and to the different strains which it must bear when in use, and its qualities of resistance indicated by the calculation have been confirmed by very recent experiments."

The merits of wrought iron wheels, it is thought, have never been fully recognized in this country. In view of this, the exhibit of the Arbel Company is worthy of careful examination by our railroad managers.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in August, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN AUGUST.

Hagerstown, Md., August 1.—A freight car on the Baltimore & Ohio Railroad, which was being loaded with wheat on the switch of the Frederick Elevator Company, got beyond

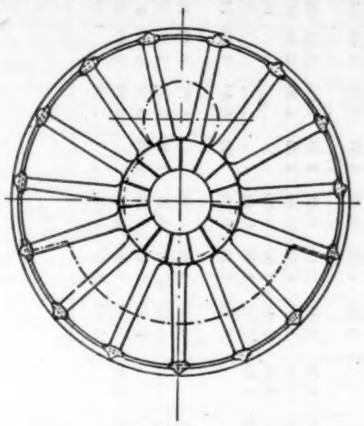


Fig. 31.

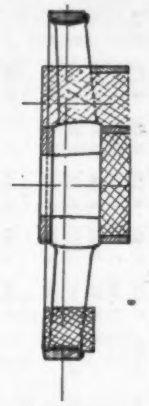


Fig. 32.

the control of the brakeman this afternoon, and running down the track came into collision with the locomotive and several passenger cars. The pilot was damaged and the end of one passenger car badly broken. William Hauer, a fireman, was caught on the platform and received severe but not dangerous injuries.

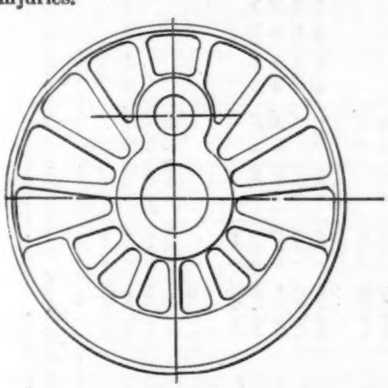


Fig. 33.

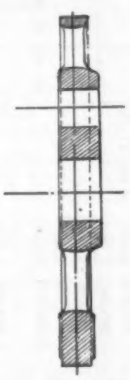


Fig. 34

Worcester, Mass., August 2.—E. H. Ford, a fireman on the Boston & Albany Railroad, was struck by a train in the freight yard last night and seriously cut on the head.

Streator, Ill., August 2.—A stock train consisting of 26 cars, on the Atchison, Topeka & Santa Fé Railroad, ran on to a side track to-night at Kinsman, 18 miles north of this city.

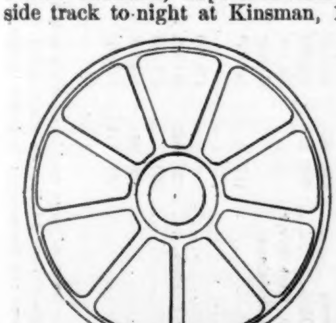


Fig. 35.

Fig. 36.

The engine was thrown from the track by striking some cars loaded with lumber and flour. Fireman J. Leary jumped and received severe injuries about the legs. Eighteen cars were wrecked and about 30 head of cattle killed. The wreck took fire, and the cars, dead stock, elevator, and depot were entirely consumed.

Macungie, Pa., August 3.—Through a misplaced switch two freight engines were badly wrecked to-day. Engineer George Leeds was considerably injured.

Danville, Ill., August 5.—An east-bound freight train on the Big Four Road broke in two on the iron bridge over the North Fork River. Another east-bound freight train came round the sharp curve to the west of the bridge, and a collision occurred. Two spans of the bridge were knocked off the pier into the river, 63 ft. below. The engine and 28 cars composing the second train and four cars of the first train went

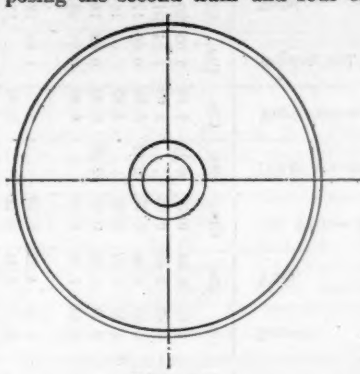


Fig. 37.

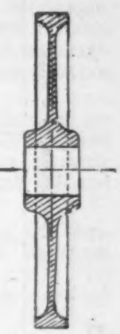


Fig. 38.

down with the bridge. Daniel O'Connor, engineer of the second train, jumped off his engine, landing on a barbed-wire fence and was severely scratched. His fireman, Frank Flannigan, went down with the engine. In some way he cleared the wreck and was not seriously hurt.

Fremont, O., August 5.—A wreck occurred 8 miles west of here at Lindsey, on the Lake Shore & Michigan Southern Railroad, this evening, at 10 o'clock. Three people were killed

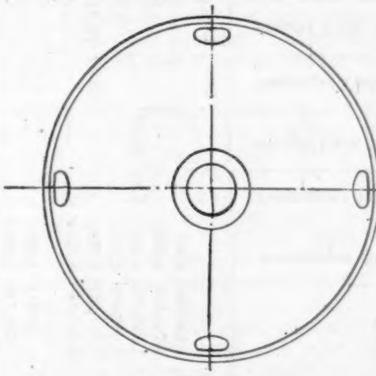


Fig. 39.

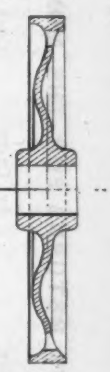


Fig. 40.

outright, and 25 were more or less injured. The Pacific express passed a local freight at Lindsey, which had been sidetracked. The express was running at full speed and passed safely until the sleepers neared the switch close to the freight, when the first three sleepers jumped the track and ran into the engine of the freight. Engineer Ed. Lafferty, of the freight train, was killed.

Laredo, Tex., August 7.—A wreck occurred on the Southern Division of the Mexican National Railroad near Colonia, Mexico, in which Engineer John Peterson lost his life. A cloud-burst had occurred in the valley on the line, washing away a bridge and considerable track. A freight train was on the line coming down at the time, and before it could be stopped the engine ran off the dump into the stream from which the bridge had been washed away.

Little Ferry, N. J., August 8.—The New York, Susquehanna & Western Railroad Company is building a bridge over the West Shore track near this point, and some timbers had been left standing near the rails. Engineer James Loane, of the New York, Ontario & Western milk train, was leaning out of the cab window as he passed this place to-day, and was struck on the head by one of the timbers, receiving a severe scalp wound.

Philadelphia, Pa., August 9.—William H. Frick, an engineer on the Wilmington & Northern Railroad, fell from his engine at Landenberg to-day, badly spraining his back.

Reading, Pa., August 9.—John Sainer, an engineer on the Philadelphia & Reading Railroad, while engaged in cleaning his engine last evening fell from his cab to the ground, severely spraining his right leg.

LOCOMOTIVE RETURNS FOR THE MONTH OF JUNE, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Locomotive Mileage. Freight Trains	Locomotive Mileage. Service and Switching.	Locomotive Mileage. Total	Locomotive Mileage. Average per Engine.	Av. Train. Passenger Cars.	Av. Train. Freight Cars.
Atchison, Topeka & Santa Fé	834	725	....	....	....	2,158,645	2,977	....	....
Canadian Pacific	612	....	526,283	755,528	484,707	1,766,518	2,886	....	....
Chic., Burlington & Quincy	542	....	....	....	....	1,678,784	3,097	5.60	18.58
Chic., Milwaukee & St. Paul	825	....	....	....	....	2,386,559	2,771	....	....
Chic., Rock Island & Pacific	564	....	609,564	906,005	402,012	1,917,581	3,399	....	....
Chicago & Northwestern	888	....	762,108	1,307,570	741,262	2,810,940	3,165	....	....
Cincinnati Southern	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	....	22	5,896	31,968	....	37,864	1,721	....	....
Delaware, Lackawanna & W. Main L.	211	195	71,075	669,541	5,100	745,716	3,824	....	....
Morris & Essex Division	160	..	177,118	165,471	93,887	436,476	2,728	....	....
Hannibal & St. Joseph	74	....	....	....	....	256,839	3,669	6.02	17.03
Kansas City, F. S. & Memphis	139	....	98,355	189,863	97,023	385,247	2,764	....	....
Kan. City, Mem. & Birm	42	37	35,320	46,914	17,765	99,999	2,702	....	....
Kan. City, St. Jo. & Council Bluffs	38	....	....	....	....	136,281	3,586	4.94	21.45
Lake Shore & Mich. Southern	586	....	523,976	765,566	432,021	1,821,563	3,108	....	....
Louisville & Nashville	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	303	741,576	....	60,807	802,383	2,648	....	....
Mexican Central	148	118	....	....	....	406,258	3,443	....	....
Mil., L. S. & Western	112	....	93,993	147,677	74,517	316,187	2,823	....	....
Minn , St. Paul & Sault Ste. Marie	....	....	....	....	....	....	....	....	....
Missouri Pacific	338	....	....	....	....	1,073 331	3,548	4.44	16.47
Mobile & Ohio	107	80	69,628	152,383	57,974	279,985	3,499	....	19.60
N. O. and Northeastern	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	617	411	466,565	896,575	282,883	1,646,023	4,005	4.80	23.1
N. Y., Pennsylvania & Ohio	253	161	158,802	394,308	160,222	713,332	4,430	5.70	19.1
Norfolk & Western, Gen. East. Div.†	....	....	126,411	273,991	56,227	456,629	2,784	5.00	20.90
General Western Division†	....	....	115,908	284,177	49,634	449,719	2,493	5.40	16.70
Ohio and Mississippi	117	....	143,249	139,561	98,850	381,659	3,262	....	....
Old Colony	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	478,079	316,150	1,013,508	1 8[illegible]7,737	....	....	....
Southern Pacific, Pacific System	720	666	691,971	....	....	1,820,639	2,734	5 53	13.86
Union Pacific	992	..	677,054	1,240,657	408,797	2,326,508	2,968	6.03	17.01
Wabash	426	364	434,999	682,304	273,284	1,390,587	3,820	5.02	16.80
Wisconsin Central	152	111	125,467	183,774	61,890	371,131	3,348	....	....

Name of Road.	Coal Burned per Mile. Passenger Train Mile. Lbs.	Coal Burned per Mile. Freight Train Mile. Lbs.	Coal Burned per Mile. Service and Switching Mile. Lbs.	Coal Burned per Mile. Train Mile, all Service. Lbs.	Coal Burned per Mile. Passenger Car Mile. Lbs.	Coal Burned per Mile. Freight Car Mile. Lbs.	Cost per Locomotive Mile. Repairs. Cts.	Cost per Locomotive Mile. Fuel. Cts.	Cost per Locomotive Mile. Oil, Tallow and Waste. Cts.	Cost per Locomotive Mile. Other Accounts. Cts.	Cost per Locomotive Mile. Engineers and Firemen. Cts.	Cost per Locomotive Mile. Wiping, etc. Cts.	Cost per Locomotive Mile. Total. Cts.	Cost per Car Mile. Passenger. Cts.	Cost per Car Mile. Freight. Cts.	Cost of Coal per Ton. $
Atchison, Topeka & Santa Fé	....	....	....	....	....	....	4.87	6.54	0.29	0.15	7.13	1.05	20.08	....	....	1.52
Canadian Pacific	....	....	....	62.69	....	....	3.89	9.86	0.33	....	5 62	1.34	21.04	....	....	3 13
Chic., Burlington & Quincy	....	....	....	81.78	....	....	4.59	5.49	0.22	0.17	6.88	0.06	17.41	....	....	1.34
Chic., Milwaukee & St. Paul	....	....	....	67.77	....	....	4.20	6.97	0.29	....	6.89	....	18.35	....	....	2.00
Chic., Rock Island & Pacific	57.34	76.21	39.20	62.44	....	....	2.99	5.69	0.27	2.99	6.04	0.43	15.42	....	....	1.96
Chicago & Northwestern	....	....	....	79.33	....	....	3.58	7.46	0.36	....	6.40	0.81	18.61	....	....	1.86
Cincinnati Southern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Cumberland & Penn.*	....	....	....	99.00	....	....	6.13	4.52	0.39	....	....	1.85	12.89	....	....	....
Delaware, Lackawanna & W. Main L.	....	....	....	81.80	....	....	3.17	6.45	0.46	....	5.84	....	15.92	....	....	1.60
Morris & Essex Division	....	....	....	62.99	....	....	4.28	9.76	0.40	....	6.36	....	20.80	....	....	3.08
Hannibal & St. Joseph	....	....	....	80.03	12.88	5.83	3.82	5.45	0.13	0.21	6.71	0.02	16.34	....	....	1.39
Kansas City, F. S. & Memphis	....	....	....	60.95	....	....	4.46	5.35	0.19	0.41	7.51	....	17.92	....	....	1 62
Kan. City, Mem. & Birm	....	....	....	....	....	....	3.79	3.09	0.23	0.34	7.19	....	14.64	....	....	0.98
Kan. City, St. Jo. & Council Bluffs	....	....	....	65.12	13.12	4.60	3.98	5.87	0.13	0.23	6.04	0.03	16.28	....	....	1.90
Lake Shore & Mich. Southern	57.42	85.02	37.46	60.87	....	....	3.06	4.74	0.18	....	6.85	0.19	15.02	....	....	1.55
Louisville & Nashville	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	....	....	40.73	....	....	3.20	8.30	0.20	....	9.00	....	20.70	....	....	4.05
Mexican Central	....	....	....	70.67	....	....	5.91	14.62	0.55	0.23	5.27	0.82	27.40	....	....	4.41
Mil., L. S. & Western	....	....	....	67.26	....	....	3.22	9.34	0.15	....	6.14	0.89	19.74	....	....	2.80
Minn , St. Paul & Sault Ste. Marie	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Missouri Pacific	....	....	....	82.65	4.32	1.66	5.25	5.75	0.46	1.44	6.41	1.36	20.67	3.95	1.57	1.35
Mobile & Ohio	....	....	....	58.91	....	....	2 63	4.32	0.22	0.63	5.75	0.93	14.48	....	....	1.43
N. O. and Northeastern	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
N. Y., Lake Erie & Western	86.50	127.20	66.2	....	17.90	5.50	4.82	7.13	0.38	2.38	7.29	1.11	23.04	....	....	1.86
N. Y., Pennsylvania & Ohio	59.30	131.80	75.5	....	10.40	6.90	3.64	6.24	0.30	2.35	6.90	0.99	20.42	....	....	1.21
Norfolk & Western, Gen. East. Div.†	46.30	121.30	....	....	9.30	5.80	5.90	3 90	0.50	....	....	....	10.30	....	....	....
General Western Division†	66.00	119.00	....	....	12.22	7.66	7.17	4.28	0.42	....	....	....	11.87	....	....	....
Ohio and Mississippi	....	....	....	80.64	....	....	3.12	3.15	0.26	1.20	5.40	1.49	14.62	....	....	0.77
Old Colony	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Philadelphia & Reading	....	....	....	74.79	....	....	4.80	4.61	0.36	....	5.77	0.42	15.96	....	....	....
Southern Pacific, Pacific System	....	....	....	67.34	....	....	5.08	17.57	0.91	1.46	7.27	1.11	33.40	....	..	5.27
Union Pacific	....	....	....	93.81	....	....	7.50	9.49	0.39	0.94	8.05	1.20	27.57	4.10	2.03	2.05
Wabash	66.68	98.52	52.11	79.46	13.26	5.86	3.58	4.35	0.30	....	6.22	0.89	15.34	2.44	1.09	1.12
Wisconsin Central	....	....	....	74.13	....	....	3.44	8.22	0.21	....	7.28	....	19.15	....	....	2. 18

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

Providence, R. I., August 9.—Owing to a misplaced switch on the Shore Line track to day, there was a collision between a freight train and an engine standing on a siding at this point. Engineer Rogers, of the standing engine, was slightly hurt by the shock, sustaining injuries to his foot.

Chattanooga, Tenn., August 11.—Charles Hardin, fireman on the Sequatchie Valley Railroad, a branch line of the Nashville, Chattanooga & St. Louis Railway, was watching the crew pull a car on the track by means of a wire rope, when the rope, which had a kink in it, snapped in two, one end striking him over the right eye, inflicting a terrible flesh wound.

Hartford, Conn., August 11.—Thomas Ford, a fireman on the New York & New England Road, was run over by a switch engine to-night, and will lose both legs. Upon coming in from Boston he was very tired and sat down in the roundhouse, just inside the door, to rest. He soon fell asleep and fell to the ground, with both legs across the rails. A switch engine backing in ran over him.

Colfax, Cal., August 14.—There was a collision in the snowsheds at Cascades, on the Central Pacific Railway, this morning at 11 o'clock. An extra train going east was run into by a work train. Engineer Isvard had his knee badly injured.

Oswego, N. Y., August 14.—A collision occurred between a freight and passenger train at Scriba, 6 miles east of here, on the Rome, Watertown & Ogdensburg Road, this evening. De Witt Gibbon, engineer of the passenger train, was found in the ditch, where he had struck when he jumped. He suffered from a dislocated shoulder and a bad scalp wound.

Fergus Falls, Minn., August 15.—A west-bound passenger train on the Great Northern collided with a freight at 3 o'clock this morning on the bridge across the Red River. No one was injured except the passenger engineer, and he not severely. The engine, however, was thrown into the river, where it is a complete wreck and partially covered with water.

Huntingdon, W. Va., August 16.—The first section of an east-bound freight train on the Chesapeake & Ohio Railway broke in two 13 miles east of this city shortly before 4 o'clock this morning, and the engine pulling the second section ran into the first. Engineer Hamilton and Fireman Lar, of the second section, were badly injured.

Baltimore, Md., August 16.—T. W. Brown, engineer on the Baltimore & Lehigh Railroad, was painfully and perhaps fatally scalded this afternoon at the North Avenue roundhouse, while making repairs to his engine. He was fixing a bolt under the boiler when a plug blew out, and he was instantly enveloped in a cloud of steam. He would have cooked alive but for the prompt action of his fireman.

Altoona, Pa., August 16.—Fireman Charles Miller fell from his engine last night while it was running at a fair rate of speed. In falling his head struck a tie and he was rendered unconscious, also sustaining severe cuts above and below his left eye.

Van Wert, O., August 17.—Engineer Fred Hall, of the Cincinnati, Jackson & Mackinaw Railroad, caught his feet in a hot-water pipe at Gilberts to day and was terribly scalded.

Dubuque, Iowa, August 17.—A passenger and freight train on the Chicago, Milwaukee & St. Paul Railroad collided 3 miles south of this city at 3 o'clock this morning. The engine and two cars went over an embankment. Fireman Samuel P. Kemp was injured.

Greensfield, O., August 17.—A freight engine on the east-bound track on the Baltimore & Ohio Southwestern Railroad exploded its boiler at Rock Bridge to-night, instantly killing Engineer Passam and Fireman Roberts.

Philadelphia, Pa., August 22.—The Norfolk express on the Wilmington & Baltimore branch of the Pennsylvania Railroad crashed into a freight train at Porter, Del., at 1.30 this morning. The cars were thrown from the track and the engineer and fireman were injured. The fireman's injuries are fatal.

Willimantic, Conn., August 23.—A head-on collision occurred between two regular freight trains on the New York & New England Railroad, 2 miles west of this place, at 12.40 this morning. The engineer and fireman of both trains escaped without injury. The fault lies with the night operator at Andover, who should have held the east-bound train until the west had passed, but was asleep. He has run away.

Belair, Md., August 23.—William Blaney, fireman on the Baltimore & Lehigh Railroad, was seriously hurt by falling from the tender of a locomotive to day. His head was cut, and it is thought he has sustained internal injuries.

Brewsters, N. Y., August 26.—A head-on collision occurred this afternoon about 1 o'clock between Ice Pond and Dykemans, on the Harlem Road. Engineer Elliott, of Train 13, and N. Best, his fireman, D. Palmitier, engineer of Train 20, and Samuel Gibney, his fireman, were killed.

Milwaukee, Wis., August 27.—Passenger train No. 2, on the Milwaukee & Northern, or Lake Superior Division of the Chicago, Milwaukee & St. Paul Railway, was thrown from the track last night at Pike Hill switch, 185 miles from this point. A portion of the train was derailed, and Engineer Ainsworth had his right leg so badly crushed that amputation below the knee will be necessary. The fireman received slight injuries.

Norwich, Conn., August 27.—H. I. Read, a fireman on the Consolidated Road, nearly lost the sight of one of his eyes by the bursting of the sight-feed glass of the air-pump lubricator, by which several pieces of broken glass were thrown into and around one of his eyes. The eyeball is badly gashed, although it is hoped that the eye will be saved if inflammation does not set in.

Pittsburgh, Pa., August 29.—Fireman J. R. Earnest, on the Pennsylvania Railroad, was seriously if not fatally injured while making his run to-night. The train was running through Gallitzin tunnel when a stone from the wall fell and struck him on the head.

Middletown, N. Y., August 29.—Nathan Bryant, an engineer on the Port Jervis, Monticello & New York Railroad, was struck by an engine while walking on the track in Port Jervis this afternoon. He received several wounds and may have suffered internal injuries.

Newark, O., August 30.—Henry McGreevy, a fireman on the Baltimore & Ohio Railroad, jumped from his engine at Mt. Vernon to-night when the cars left the track. He was considerably bruised, besides having one shoulder dislocated.

Brenham, Tex., August 31.—A south-bound freight train loaded with merchandise was wrecked and partly burned 10 miles from here on the Gulf, Colorado & Santa Fé Railroad to-day. Jack Swanson, the engineer, was killed, and Fireman Dameron was fatally injured.

Baltimore, Md., August 31.—Through the carelessness of a flagman a collision occurred between a train on the Baltimore & Ohio Railway and a standing engine at Hanover and Wells streets this morning. As a result Engineer Maskell was badly scalded, and Fireman Sittler had his leg crushed to a pulp.

Springfield, Mass., August 31.—A Chicago limited express for Boston, on the Boston & Albany Railroad, broke through a frail iron bridge 1¼ miles east of Chester at about 12.30 to day. Four Wagner cars were crushed and at least 13 persons killed, while many others were badly hurt. The bridge was being strengthened for heavy locomotives when the accident occurred, the workmen being at dinner at the time. The engineer, William Horton, was buried beneath the locomotive, and was very severely injured.

Albany, Ga., August 31.—The Cannon Ball train from Montgomery for this place met with an accident on a trestle just this side of Georgetown over Mercer's Creek. During the night a portion of the trestle was undermined and washed away. The damage was not discovered until the train was within a short distance of the point, when the engineer, realizing the great danger, told his fireman to jump. He applied the air-brakes and brought the balance of the train to a standstill just as he and his engine fell 45 ft. below. The fireman escaped with a few bruises, and, in spite of his terrible fall, the engineer was not seriously hurt.

Our report for August, it will be seen, includes 35 accidents, in which six engineers and five firemen were killed, and 18 engineers and 16 firemen injured. The causes of the accidents may be classified as follows:

Blowing out of plug	1
Breaking of wrecking apparatus	1
Bursting of gauge-glass	1
Caught by hot pipe	1
Collisions	11
Derailments	2
Explosion	1
Failure of bridges	2
Falling from engines	4
Misplaced switches	4
Run over	1
Struck by obstruction	2
Struck by train	2
Unknown	1
Washout	1
	35

DANGERS FROM REAR-END COLLISIONS.

To the Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

IN common with other readers of your valuable JOURNAL, we have been greatly interested in the monthly account of "Accidents to Locomotive Engineers and Firemen," reported in your columns. These reports not only send a thrill of horror through sensitive souls, but shake the serenity of even the most stolid and indifferent corporations. They must tend also to arouse the practical mind to the fullest bent of ingenuity to devise methods of cure and prevention. Accidents will happen, must happen, in every human scheme, and perils are incident to the most perfectly devised human undertakings. The question is how to lessen their number and mitigate their horrors.

Since your JOURNAL has taken up the problem with so much earnestness, and invited suggestions from every quarter, we respond with the alacrity born of assured experience. Theories on such a subject may be good, but demonstrated facts are better. We point to the facts.

It is well known in railroad circles that of all classes of accidents, rear-end collisions are among the most frequent and deadly. Statistics show this conclusively. Your monthly reports show it. Only last month several accidents of this nature occurred, accompanied by such harrowing details as these, which we find in your columns: "The engineer, fireman, and passengers"—one or many—"were literally cooked by the escaping steam, great pieces of flesh falling from them;" others were "injured for life," and the wreck rendered unapproachable by the scalding steam, so that nothing could be done to rescue the wounded or stop the destruction and damage to property.

Five or six years ago, a practical railroad man, realizing the perils from this cause, and moved by a recent disaster that cost the lives of more than a score of employés and passengers, besides hundreds of thousands of dollars in damages, set his brains to work to invent a safeguard. The result was the McDowell inside safety-check-valve for locomotive boilers. As soon as it was completed your JOURNAL devoted several columns of its valuable space to a full description and illustration. The device was soon after adopted by some of the largest and most progressive railroads of the country.

Since that time the McDowell check has grown steadily in official confidence and favor. The Pennsylvania Railroad equipped its whole system with it, and the Erie, Lehigh Valley, Philadelphia & Reading, Chesapeake & Ohio, Chicago Southside Elevated, and numerous other roads applied it. From every direction most gratifying reports have been noted of the efficient and invaluable service it has rendered. This device is still in the market, still accessible to all concerned, and it has become a standard appliance in railroad equipment.

The valve being located inside instead of outside the boiler, is absolutely protected in cases of collisions which break off the feed-water connections. In the event of accidents referred to, the valve closes automatically on the inside, thus effectually preventing the escape of steam. In other respects it meets all requirements of a perfect safety check-valve. While many railroads are now employing it, there are hundreds of others who have probably never investigated its advantages, and it is the purpose of this communication to stimulate, if possible, this wider inquiry in railroad circles.

It has been demonstrated, in more than one instance, that the presence of the McDowell check has saved to the company using it many times what it would have cost to equip every locomotive on its road with the valve. Leaving humanitarian considerations out of the question, saying nothing of the value of human life, economical and practical considerations alone should induce all roads to apply this simple, cheap, life and property-saving device. It may be said, in fact, that railroad employés and the public will sooner or later demand some such safeguard.

Yours respectfully,

J. M. FOSTER.

ARMOR TRIALS AT INDIAN HEAD.

To the Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

THE armor trials at the Indian Head proving ground, on July 11, are interesting, both from the splendid behavior of plate and projectile, as well as from the fact that the plate was thicker and the gun of larger caliber than had ever before appeared upon an American trial ground. It may also be said that the 17-in. plate represents about the maximum thickness of practicable armor. Beyond this point increased resisting power will be sought in an improved quality of metal rather than increased thickness.

The first trial was of a test plate of the *Monadnock's* 9-in. nickel steel armor, from the Carnegie works. The 8-in. gun, even with the reduced velocities employed, was more than a match for this thickness of plate, and all of the three projectiles fired got their noses through the metal. The interest of the trial centered, however, in the second plate, representing the barbette armor of the battleship *Indiana*. It was of nickel steel, from the Bethlehem works, and 17 in. in thickness.

In this trial the full weight, 850-lb. projectile was used, but the velocities were all below the capacity of the gun, beginning with 1,322 foot-seconds in the first and ending with 1,858 in the third shot. The penetrations were 16.6 in. for the first and 20 in. for the second shot, which fairly got its point through the plate. The third shot, with a striking energy of 21,000 foot-tons, made a clean perforation through the plate, passed through the 50-in. oak backing, a bank of earth, and disappeared in the woods beyond. The calculated steel penetration of this last projectile was 18.04 in.

The most remarkable and unlooked-for features of the day's trials were, that of the five projectiles recovered all were practically uninjured, and that in neither of the plates was a single crack developed. It is interesting to speculate as to the result had these plates been face-hardened—Harveyized. Cracks, no doubt, would have been produced by the terrific blows delivered, but it is not at all likely, judging from previous trials, that in any case would the projectiles have perforated the metal.

The preliminary trial of the Brown segmental wire-wound gun at the Sandy Hook proving ground calls attention to the fact that this type of gun is likely to be thoroughly tested in the near future. Beside the Brown gun, above referred to, the ordnance 10-in., cast-iron, wire-wrapped rifle is on the ground ready for trial, and it is understood that a Woodbridge 10 in. steel, wire-wound gun is also about ready for its test.

H. M. CALIFF.

MANGANINE.

ON account of its high specific resistance and small negative temperature-coefficient, manganine, composed of copper, 83 per cent.; nickel, 4 per cent., and manganese, 13 per cent., is stated by a German electrician to be especially valuable in the manufacture of resistance coils. He found that after such a coil had been heated to about 212° F., its resistance was diminished by from 0.4 to 0.8 per cent.; but on repeating the process the alteration became less and less, until it amounted to no more than $\frac{1}{10000}$ of the whole. He recommends, therefore, that the coils should be heated to 225° and kept at that temperature for some hours every month, in order to get rid of the molecular disturbances due to the processes of manufacture, and that they should be well paraffined to preserve the alloy from air and moisture.

PROCEEDINGS OF SOCIETIES.

New York Railroad Club.—The New York Railroad Club held its first meeting of the season on Thursday evening, September 21, at the rooms of the American Society of Mechanical Engineers, which were filled. The discussions for the evening took a topical form, and that which attracted most attention was the inquiry into the advisibility of removing jacks, pinch bars, saws, and other heavy tools from the locomotives. Mr. Mitchell, of the New York, Lake Erie & Western Railroad, stated that the experience of that road was to the effect that jack screws and other tools which were kept upon the locomotive were liable to become wet through carelessness on the part of the trainmen in spilling water from the water tanks, and also from leakages from storms; furthermore, that the lighter tools, which were easily portable, were more than apt to be stolen either by employés about the shops or outsiders, who have no connection with the road. Under these circumstances the jacks were apt to become rusted, and in case of an emergency it was impossible to use them. They had, therefore, removed all jacks from the locomotives, and now kept two extra jacks at each station; and as the stations are not far apart, it is of course possible to obtain a jack by going a short distance for it In place of these tools, the engine carried a full set of blocking, such as would be ordinarily required in case of accidents which are most likely to occur, such as blocking for holding the cross-head in position, etc. Several of the members agreed that this was the simplest and

best way of handling these tools; but, on the other hand, it was contended by a number of members that these jacks were frequently wanted quickly, and that the emergency was often such as to render the delay of going to a depot a matter of life and death, especially where it is necessary to raise an engine or car from the body of a man who is pinioned beneath them.

Several members stated that they had no difficulty whatever in keeping their jacks in perfect condition and ready for use at all times. It was suggested that the imitation of European practice of keeping the jack on a running board and held in position by a bracket, where it will be in sight of inspectors at all times, and must be screwed down in order to keep it in position, was a good one.

Another topic for discussion was that of the advisibility of sending out engines with the eccentrics held by set screws alone. This practice was almost universally condemned, and all who spoke favored the use of keys very strongly. The objections that the key allowed of no adjustment of the eccentric in case it were desired, such as a variation of the lead, were met with by the fact that an off-set key could be very readily made and used. The use of keys driven in over a flat spot on the axle was not approved of. One suggestion was made as to the best way of holding the eccentric which seemed to meet with general approval. It was that the key should be let one-half into the axle and one-half into the eccentric. That two set screws should be used, and these should, in turn, be furnished with check-nuts, so as to take up what little variation there might be in accuracy of workmanship. After the eccentrics are in position, the two should be bolted together so as to prevent either one of the essentrics from shifting laterally until all of the screws had become loosened. With this arrangement it was contended that the eccentrics would give the best satisfaction. Some complaints were made that set screws that were tightened up and available to the engineer for such purposes would give trouble by springing the eccentrics themselves, causing them to heat. This had been the experience of several members. There were one or two other topics which were brought up for discussion, but they received practically no attention whatever.

Technical Society of the Pacific Coast.—At a recent meeting Mr. J. Richards presented a paper on Some Problems in Pumping Fluids, in which he made a comparison between the use of centrifugal and piston pumps, giving the former the preference in regard to economy of work and capacity. He said, in making this comparison, that a piston pump of 8 in. bore is set down for a duty of 120 galls. per minute, and a centrifugal pump of like bore at 1,200 galls. per minute, the proportion being 10 to 1. This comparison being made on the basis of flow capacity and with no reference to other efficiency or consumption of power in proportion to the work performed. In considering the question of cost, he stated that the flow capacity of 10 to 1 was qualified by the first cost of the two machines, which shows that a piston pump costs for a given volume of duty 20 times as much as a centrifugal pump. In respect to efficiency, or the consumption of power in proportion to the work performed, the difference in efficiency is also in favor of the centrifugal type. An evidence of this lies in the fact that the trade circulars issued include the efficiency of centrifugal pumps, but not of piston pumps. Contracts made for centrifugal pumps nearly always include stipulation as to the duty to be performed with a given amount of power, but this is not the case in respect to piston pumps of the commercial class, and their efficiency is, no doubt, much less.

The obstructions to efficiency, such as injuries, liability to derangement, steadiness of motion, and other features of this kind are in favor of the centrifugal pump. This comparison was made to show the economical difference between continuous and intermittent action, which is the chief distinction between these two methods of pumping. There is no reason why 1,200 galls. per minute should not pass through the piston pump, the same as it does through the centrifugal one, if there were not limitations of some kind that take away nine-tenths of the capacity of piston pumps. If we turn to the suction and discharge pipe of piston pumps, we find that they have a capacity of only one-third or one-fourth as much as that of the pump's bore, or comparing with centrifugal pumps about one-seventh as large, and are in proportion to the flow in the two cases. Here, then, is an anomaly: two machines for impelling water under like conditions for average heads, one costing twice as much as the other and performing one-tenth of the duty. The dimensions, weight, and first cost of pump machinery are inversely as the velocity with which the water passes through it. The limitation of duty in reciprocating piston pumps amounting to from eight-tenths to ninetenths of their normal capacity is due to the intermittent and irregular flow.

Professor Riedler, of Berlin, Germany, about 10 years ago began a series of investigations respecting the action of piston pumps, that with some other experiments of the kind is destined, no doubt, to cause a great change in practice. Professor Riedler's indicator diagrams taken from common pumps are monstrosities. No one would suspect that such flows as here appeared existed in pumps of any kind. The result of these researches was to increase the flow to 5 ft. per second, or about five times the former velocity, without the least shock or jar. They consist in positively operating the valves by mechanism independent of the action of the water, and so constructing water ducts that there is but little change of velocity as the water passes through the pumps. This system has also been adopted by Mr. E. D. Leavett in designing some pumps for the Lynn Water Works.

PERSONALS.

William Greene is now General Manager of the Cincinnati, Hamilton & Dayton Railroad.

D. G. Edwards has been appointed General Passenger Agent of the Cincinnati, Hamilton & Dayton Railroad, the appointment taking effect on September 1.

Mr. Thomas G. Clayton, of Derby, Superintendent of Car Construction of the Midland Railway of England, was among the passengers on the steamer *Lucania*. He comes as guest of his brother, Mr. James Clayton, President of the Clayton Air Compressor Works, New York. While here he will visit the World's Fair and make a study of the railway systems of this country.

Lucius Tuttle, who has recently been elected to the Presidency of the Boston & Maine Railway, began work as a ticket clerk on the Providence, Hartford & Fishkill Railway in 1865, later was General Ticket Agent of this road at Hartford, going to Boston in 1878 as Assistant General Passenger Agent of the New York & New England Railway. Within a year or two he was General Passenger and Ticket Agent and Assistant to the General Manager of the Eastern Railway, serving on this road about six years. In 1885 he became General Passenger and Ticket Agent of the Boston & Lowell Railway, serving two years, and after the consolidation he became Assistant to General Manager Furber, of the Boston & Maine. In 1887 he became General Traffic Manager of the Canadian Pacific Road at Montreal. In 1889 he was made a Commissioner in the Trunk Line Association passenger department, and in May, 1890, he went to the New York, New Haven & Hartford Railway as its General Manager. In February, 1892, he was appointed its Vice-President, and has since held that position.

OBITUARY.

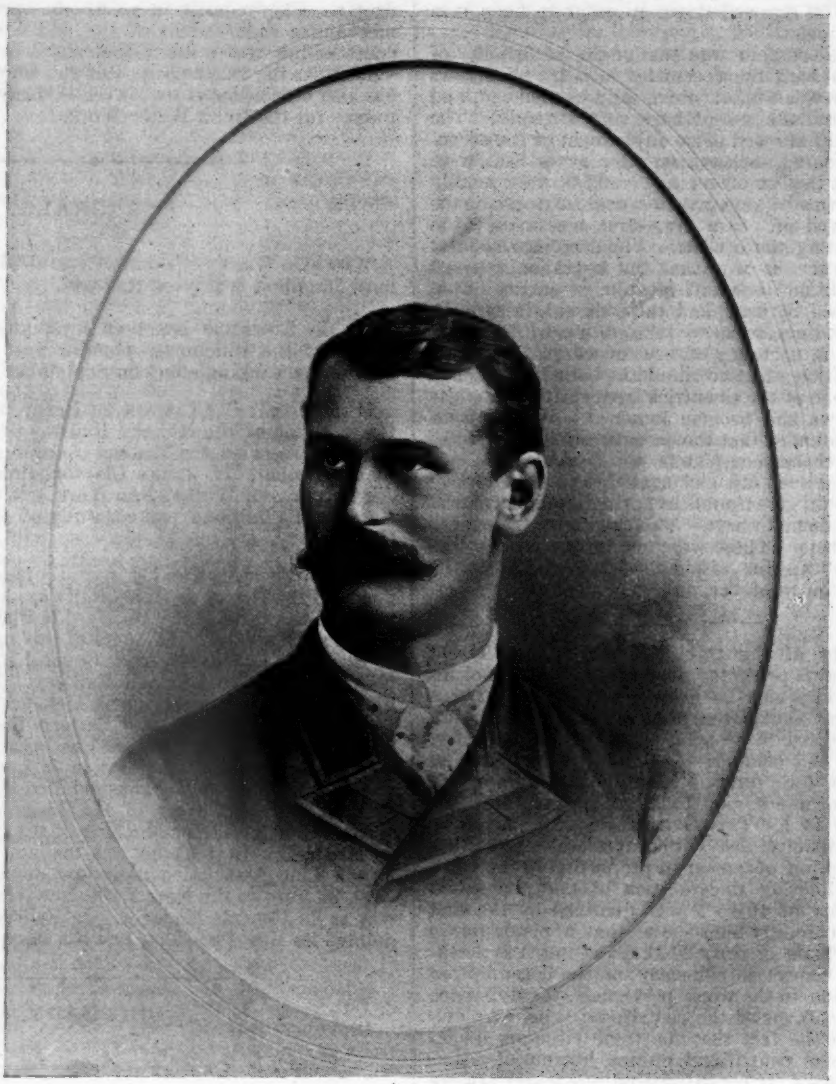
Charles Roberts Johnson.

To those who knew him only in business relations or by reputation alone, the name of Charles R. Johnson—whose death occurred at Saranac Lake in the Adirondacks of New York on September 11—will be associated with his occupation, which was that of a signal engineer, in which he was the most eminent authority in this country. Those who had the privilege of a more intimate acquaintance and friendship knew him not only to be a man of very marked ability as an engineer, but as a person whose character had a charm which attracted all who learned to know him, and were susceptible to the influence of a noble and generous nature.

He was a native of England, and was born in Higham Ferrers in Northamptonshire on January 17th, 1851. His father still survives him, and is William C. Johnson, who married Charlotte Sanders. The elder Johnson's first occupation was that of a builder, and later he was employed by the firm of Stevens & Sons, makers of railway signals in London.

Charles R. Johnson was educated at Dr. Pinches's academy in Kennington, London, and his first employment was in the drawing office of the City Architect in that city from 1867 to 1869. He remained there about two years, and then went into the employ of a Mr. Head, a builder, to make estimates and oversee work. When he was 23 years of age he made an engagement with the Messrs. Stevens & Sons, manufacturers of signals in London, where his father was employed. His work there was

to oversee the erection of signals. At the same time his uncle, Mr. Henry Johnson, was superintendent of the erection of work in the North of England, Scotland, and Ireland, for the celebrated firm of Saxby & Farmer, of London, the leading firm of signal engineers in England and probably in the world. This relation of the uncle led to an engagement of the nephew by the same firm, and in 1875 he entered their employ. He was at first associated there with his uncle, and had charge of the erection of work on different English railways. This gave him great familiarity with the difficulties and complications which are constantly encountered in adapting signals to the requirements of different locations and conditions. The amount of traffic on some of the English lines was then very much greater than on any of our American roads. Consequently systems of signals had to be developed and perfected there and adapted to the requirements of the traffic long before similar appliances were needed here. In putting up the signals made by Messrs. Saxby & Farmer, Mr. Johnson had the most abundant opportunity of becoming acquainted with all the multifarious details of their construction, the conditions they had to fulfil, the difficulties to be overcome, and the dangers to be guarded against. He therefore acquired a wonderful knowledge of the principles of railway signaling, and the intricacies growing out of a vast and complicated business which had to be controlled by the appliances which his firm were providing. He not only had charge of this work in England and Ireland, but in 1879 he was sent to France to superintend work which was done on some of the principal lines there. In 1880 he was sent to India as the representative of the interests of Saxby & Farmer in that country. While there he was much exposed to the influence of the climate, and contracted jungle fever, from the effects of which he never fully recovered. He remained in India only about a year, and then, owing to his illness, went to Australia, where he spent a few months, and then returned to England. This was in 1881.



Yours Sincerely
Charles R. Johnson

To understand "the state of the art" of signaling in this country at that time, it must be remembered that interlocking and block signaling were then almost unknown here. In 1873 Messrs. Toucey and Buchanan, of the New York Central & Hudson River Railroad, erected a system of interlocking signals and switches at Fifty-third Street, where the incoming and outgoing tracks of the Grand Central Depot in New York crossed each other. The plans of this apparatus were brought to this country by two brothers named Brierly, who had been in Saxby & Farmer's employ in London, and it was a modification of the mechanism used by that firm. Later a similar interlocking system was put in at the Spuyten Duyvil junction of the same road. This mechanism afterward was much improved by Messrs. Toucey and Buchanan. During the Centennial Exhibition in Philadelphia, in 1876, the Pennsylvania Railroad Company erected some interlocking signals of the Toucey-Buchanan-Brierly system to control the traffic at the terminals of their line, adjoining the exhibition grounds, and a little later a Saxby & Farmer apparatus was placed on that road at the junction east of Newark, N. J.

The first use of block signals controlled by telegraph in this country was on the Pennsylvania Railroad about 1873. In 1876 Messrs. Saxby & Farmer exhibited at the Centennial Exhibition a very complete model of their system of interlocking signals, and also some of the apparatus employed in it and in block signals. It may be said that the acquaintance of many railroad men in this country with the systems of signals used in England dates from this exhibit. The need of better methods of controlling the movement of trains on our railroads had been experienced on many of our roads, and a number of railroad officers had attempted to evolve some system, adapted to their needs, out of their inner consciousnesses, or they sought the aid of some inventive genius to help them out of their difficulties. Some of these attempts were of a fearful and wonderful character. The imaginations of railroad men and inventors ran riot in devising different forms of targets, disks, and objects with length, breadth, and thickness to be used as signals. Under the circumstances which then existed, it now seems remarkable that railroad managers here, having experienced the need of more perfect and systematic appliances for controlling the movement of trains, were not disposed to profit by the knowledge and experience of foreign railroad managers in this direction. The demand for better appliances being apparent, it would be supposed that if there was any place in the world where more

complete systems had been used for a long time, and had been developed and perfected, that those who were without such knowledge and experience would be willing to profit by that which others had acquired. Human nature, however, does not seem to work that way. Innumerable failures seem to be needed to teach most of us—railroad managers included—wisdom, and incline us and them to be guided by those who know more than we and they do. It was so in this country regarding signals. In 1881 the Pennsylvania Railroad Company had experienced so much trouble with the crossing of their line with the Central Railroad of New Jersey at Elizabeth, and with other signal problems on their road, that they sent to Messrs. Saxby & Farmer and asked whether they could send a competent person to this country to advise them in regard to signaling. That firm recommended Mr. Charles R. Johnson, and it was under that engagement that he first came to this country. It may be said that he was the first engineer who was thoroughly and practically familiar with the systems in use in Europe, who was placed in charge of the construction of signaling systems here. On his arrival he made an investigation and report on the insoluble problem of the Elizabeth grade crossing and some other analogous subjects, and was then engaged by the Union Switch & Signal Company of Pittsburgh, which had been organized some years earlier, and had engaged in the manufacture of signals. During the first part of his engagement with this company he acted as a contracting agent for it, with his office in New York. Later he was made General Manager and removed to Pittsburgh.

In 1887 Mr. Johnson was married to Georgina Miller, daughter of Mr. George W. Miller, a noted lawyer of New York City. Mr. Johnson's character was well suited for domestic enjoyment, and from its beginning to the end his married life was to him an unfailing source of happiness, the delight of his friends in a like state and the envy of those who were less blessed. He was a member of the New York Athletic and Raquet Clubs, and of the American Society of Civil Engineers.

In 1888 an unfortunate disagreement with the officers of the Union Switch & Signal Company led to a separation, and Mr. Johnson then organized the Johnson Railroad Signal Company, whose works were established at Rahway, N. J., and of which he was the President and General Manager. The formation of this company was the realization of a dream which he in common with all ambitious men feel—that of being at the head of an enterprise of which they have the control. He worked at it with the energy which came from the hope of success and confidence in his capacity for achieving it. His expectations were not entirely unfulfilled. The enterprise was fairly launched and afloat and started on a prosperous voyage, when indications of failing health manifested themselves, at first at infrequent periods, which allowed him to give his time and labor to his much-cherished scheme; but just as success was assured, the warnings could no longer be disregarded, and in May, 1892, he gave up active business, and went to the Adirondacks with the hope that rest and out-door life would lead to recovery. Alternately hoping and fearing, he improved at times, but never quite recovered what he had before lost. His illness was long and sometimes painful, but he encountered that great enemy of the human race—consumption—with fortitude and resignation, and at last passed away peacefully. During all of his illness he was surrounded with friends who were very near to him, and was tenderly cared for. The last few months of his life were spent in a camp on Saranac Lake, where everything which could contribute to health or promote recovery was available. None of these were efficacious, and when the first autumn leaves began to glow with color, it was plain that the end was near, and on a quiet September day it came, and the life which had been so useful and made so many glad was ended.

The place where he died being accessible only by water, before the last solemn rites were observed the burial case was placed in a boat, and attended by those who were nearest and dearest to him, a sad train of frail vessels moved over the placid surface of the lake on a beautiful September afternoon, and thus began the journey to his last resting-place on earth in Mount Hope Cemetery in Rochester, N. Y., where he was buried.

Those only who had the privilege of intimate friendship with Charles Roberts Johnson can know how difficult it is to do justice to his character. Of his professional knowledge and ability little more need be said. The striking trait was the clearness and soundness of his judgment and opinions. He was not remarkable for ingenuity, and he once expressed thankfulness that he was not an inventor—the implication being that ingenuity was liable to interfere with or refract the inferences, opinions, and conclusions of an ingenious person, which unquestionably it often does. It may safely be said that in matters pertaining to his specialty of signal engineering there has never been any one in this country with as thorough a knowledge of that field, and whose opinions and advice could be so implicitly accepted.

As a friend and companion the charm of his character was indescribable. He was frank, generous, and thoughtful of the happiness of all. He was as considerate and courteous to his colored man who blacked his boots as he was to the president of a great railroad. While almost feminine in his tenderness, he had an amount of stored-up energy which was limited only by his physical strength. With a temperament which was cheerful under all circumstances, he was sympathetic and always ready to enter into the feelings and help those who were unfortunate. His ability and sterling integrity were recognized in many cases too late for him to reap the full benefit therefrom and which he had so fairly earned by an honorable life, by intelligent and faithful devotion to his occupation, to his patrons, his friends, and in some instances to his enemies.

He leaves a wife who, with many friends, will always miss his pleasant smile, his charming companionship, and the sincere affection in which they all had occasion to rejoice.

Hayward A. Harvey.

Hayward A. Harvey, the inventor of the Harvey process for armor plates, died at his home in Orange, N. J., August 28, being in his seventieth year. He was the son of Brigadier-General Thomas W. Harvey, and was born at Jamestown, N. Y., January 17, 1824. His father was a millwright and inventor of the gimlet-pointed screw, the cam motion and the toggle joint; and 60 years ago built at Poughkeepsie the first machinery for making screws. Young Harvey, after getting an academy education, went into a New York company as draftsman, then took charge of a wire mill, entered into business with his father, and after his father's death in 1854 continued in the same line. During the 20 years, 1870–90, he gave practically all his time to the invention of machinery; but finding that certain experiments with steel showed promise of great success, he gave up everything else, and continued them until the great result was reached of a steel armor plate which now in its perfection sustains more and greater tests than any other. Mr. Harvey first and last took out about 125 patents, and dies with his name attached to the utmost achievements in the line of defensive armor for the navies of the world.

General Notes.

The Akron Tool Company, of Akron, O., have just received an order from the Chicago, New Orleans & Texas Pacific Railway for 30 of McNeil's patent balanced charging barrows for use at their coaling stations.

Pressure Regulators.—The Foster Engineering Company, of Newark, N. J., has just received, from the Consolidated Car Heating Company, of Albany, N. Y., an order for 50 pressure regulators for the steam heating of trains.

Latrobe Steel Works.—The recent report in one of the trade papers that the Latrobe Steel Works had shut down for an indefinite period, and had discharged its hands, is, we learn, without foundation, as they have been running continuously since their works were first started, and are prepared to execute all orders with promptness.

The Link-belt Machinery Company of Chicago.—This company has recently built and erected in the new retail store of Marshall, Field & Company, corner Washington and Wabash avenues, a Link-Belt elevator for handling boxes, bundles, etc., from the first to second and third floors. A like elevator to handle books and paper was furnished Shea, Smith & Company, printers, Chicago, for their new factory, while a similar outfit was built for the Chicago *Herald* some time ago for carrying folded papers from press-room to delivery-room.

The Stirling Company.—This company, whose shops are at Barbeton, O., have recently taken orders from the Minneapolis Electric Company for their water-tube boilers of 750 H. P., and a similar order from I. B. Mattingly Company, of Louisville, Ky. (a second order). The Taylor Chair Company, of Bedford, O., have also given an order for 150 H. P. More recently they report the following sales:

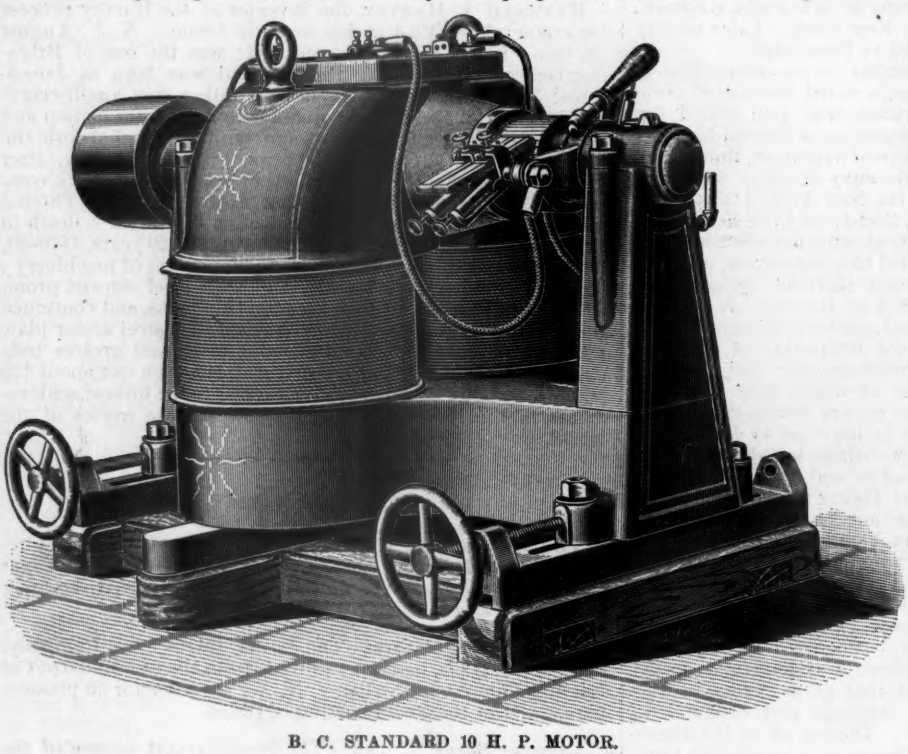
100 H. P. boilers for Salem, Mass.
400 " " " Algonquin Coal Company.
250 " " " Lutz, Libby & Co., of Park Place, Pa.

Like the boy who was fishing, they have a number of bites, and their agent, Frederick A. Scheffler, of 74 Cortlandt Street, New York, says: "Inquiries are coming to us to a greater extent than they did in July and August, which shows that business is unquestionably improving throughout the country."

Reading Iron Company.—This company wish the fact to be known that their "Scott Foundry Department" has one of the best-equipped foundries, machine and boiler shops in the country, and is prepared to undertake work of the heaviest character.

The machine shop is equipped with tools of the largest size, such as a 10-ft. planer, a 10-ft. lathe, 20-ft. boring mill, and 42 in. slotting machine, besides many special machines, such as a floor-boring machine, roll and gun lathes. The company is thus enabled to handle a class of work which comparatively few shops can execute. One of their specialties is the boring of long cylinders and axial holes through shafts.

In the foundry castings can be made of 40 tons weight. Besides cupolas it is equipped with three air furnaces from which charcoal gun-iron castings of the highest tensile strength are made. These castings, it is claimed, are preferable to steel castings for both steam and hydraulic cylinders, cranks, crank-shafts, gearing, cross-heads, and many other purposes.



B. C. STANDARD 10 H. P. MOTOR.

In the blacksmith and boiler shops very heavy work can be done. The company operates its own blast furnace, rolling-mills, tube works, steam forge, foundry, and machine works.

Manufactures.

BELKNAP MOTORS AT THE FAIR.

THE first of the exhibitors in the Electrical Building to complete their display were the Belknap Motor Company, of Portland, Me., who show a very interesting collection of motors, fans, generators, etc. The exhibit occupies Space 2, Section 3.

The apparatus shown is nearly all in actual operation, and is driven by a 10-H. P. 220 volt "B. C." (Belknap Standard) motor. This operates a 100 light standard dynamo of 110 volts. The current generated by this machine is used to operate the various pieces of mechanism, lamps, etc., comprising the exhibit. Prominent among the machines shown is a combined exhaust fan and motor of 1 kilo-watt capacity, running at 670 revolutions. The motor is multipolar, and can be run in either direction with equal efficiency. The combined machine has but two self-oiling bearings, one at either end of the shaft. The armature of the motor is built on a cast-iron sleeve together with the commutator and enclosing heads, so that it can be readily removed from the shaft by simply slacking a set screw. The armature core is built up of soft iron wire wound between the two end disks, the return wires being run across at 90° to adapt it to the four-pole magnet. A series of cross connections in the commutator permit the use of only two carbon brushes, also placed at 90° apart and situated in the most convenient position for adjustment.

A long-range spring is used for feeding the carbons, and the brushes require but very little attention. The field magnet consists of a single casting with a projection at the commutator end for supporting the bearings, and a part of this casting completely encloses the two field coils in such a manner as to protect them from injury. These are wound on metallic spools and are easily put in place or removed at will.

The generator also runs three motors of 5, 3, and 1 H. P. respectively, and also a little ½ H. P. motor which operates a moving sign. This sign is in itself a striking feature of the exhibit. It is 8 ft. high and 5½ ft. wide, and consists of two frames separated at the bottom and resting against one another at the top like an easel, or, to be more exact, like a hen coop. On these frames are stretched the sign proper, having the name of the company in letters cut out of the background, and allowing a moving piece of canvas to be seen through them. This is painted in various colors horizontally and diagonally, so that when operated by the motor the letters constantly change color in unexpected ways. The same motor also runs two revolving fans at the top of the sign, each carrying colored incandescent lamps above the frame, as well as several inside to illuminate the perforated letters.

Other important machines forming part of the exhibit are several "Cyclone" power mills electrically operated and made exclusively by this company.

Perhaps the most interesting device in the exhibit is a portable rotary electric drill with a magnetic attachment which holds it against the work while in operation. This machine is light enough to be easily carried in one hand, and is applied at once to any part of the casting to be drilled, the necessary power being taken from the nearest lamp-socket. It consists of a small electric motor made entirely of wrought iron, running at high speed and geared with a ratio of 1 to 10 to a spindle that carries the drill chuck, and has a sliding feather which allows it to move back and forth in obedience to a hand-feeding screw at the end. The frame for the support of the motor, spindle, and gearing is all of one iron casting. The drill is held against the work by a magnetic "sucker" consisting of a cup shaped piece of cast iron enclosing a coil wire taking its current from a shunt from the motor.

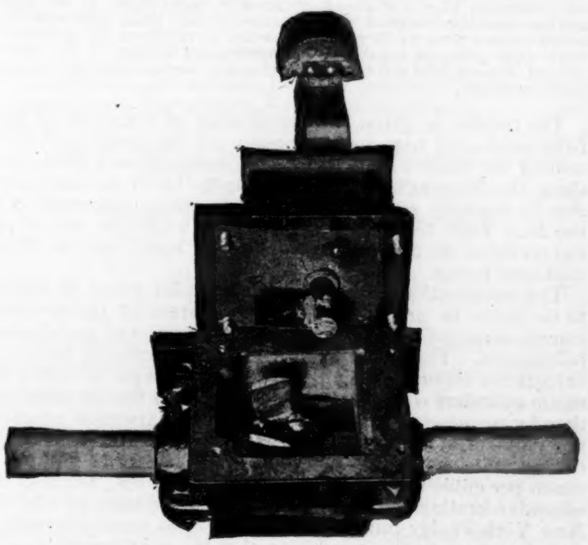
The same generator that furnishes the current to the motors, etc., also operates both arc and incandescent lamps about the space, while in the center stands a 250-light incandescent generator showing the company's workmanship in machines of this class. The Belknap Motor Company build dynamos of from 5 to 500 lights and motors from ⅛ to 50 H. P. Their ammeters and voltmeters are also shown. Besides these there are specimens of combined dynamos and water motors, as well as a 60-light dynamo coupled directly to a high-speed engine built by H. R. Stickney, of Portland, Me., while a number of revolving fans on ornamental standards about the space kept things cool enough for comfort during the hot weather.

Mr. G. W. Brown, the President and General Manager of the company, is himself in charge of the exhibit.

THE UNIVERSAL ELECTRIC CONDUIT.

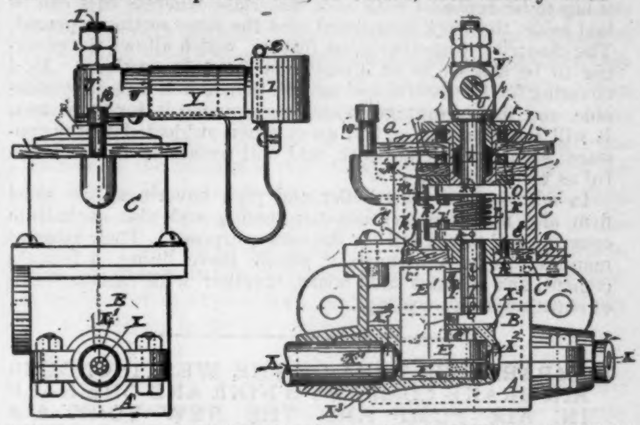
THERE has been on exhibition at Coney Island, during the past season, a short electric railway with a conduit for carrying and distributing electricity to the cars while in motion. The road that has been operated is the old right of way of the Boynton Bicycle Road, which is well known to all frequenters

of Coney Island. The conduit is of a very simple construction, and need be nothing more nor less than an opening in the street, with proper arrangements made for drainage. The insulated conductors are laid in the bottom of this conduit, and at intervals of 7 ft. are connected with a box from which the electric current is let out to the car. Two cables are used in the conduit, one being employed for the return current, as it has been found to be more reliable, and as causing less resistance than the ordinary return circuit through the rails. This does away with the necessity for bonding rails and all sparking between wheels and rails. The boxes from which the car takes its current are located in the track in question at 7 ft. intervals, alternated on the two cables, so that there is really a box every 3 ft. 6 in.; but in future constructions it is the intention of the company to place these boxes at 10 ft. intervals alternating, so that it will require but one for every 5 ft. of track. The arrangement by which the car takes the current is a very simple one. Suspended from the axle and free to move any amount in a lateral direction is a long copper-shod shoe that will be made but very little less than the total length of the car. This is suspended by two flat plates that come up through the slot in the conduit, which may be made of any width to suit the requirements of the franchise under which the road is to be operated. As this shoe is at least 10 ft. long under present conditions, and will be made from 16 to 20 ft. long under the new construction, it will be seen that it



DISTRIBUTING BOX OF THE UNIVERSAL CONDUIT.

is always in contact with the contact points from the box on each cable. The two sides of the shoe are insulated from each other, and are connected with the positive and negative contact points of the motor by way of the switch on the platform. The boxes which furnish the current for the car, to which we have made allusion, really constitute the keystone of the whole system, and are of an exceedingly simple construction. They consist of a cast-iron box about 8 in. long and 4 in. square. The cable, which is insulated, enters the box, and for the distance through it is stripped so that there is a possibility of getting a contact with the wires. On this stripped portion of the cable a brass clip is fastened which is of a V-shape, and in between the arms of the V there is a copper brush pivoted to a stem which rises through the top of the box, and which carries an arm shod with a copper shoe projecting out toward the center of the conduit; this brush is normally held by springs in a central position between the arms of the V, so that it is not in contact with it. The upper contact point, however, projects so far out toward the center of the conduit that the shoe of the car pushes it to one side and swings the brush around so that it comes in contact with one arm of the V; thus contact is made between the shoe and the cable. This, of course, as we have already pointed out, is done on either side, making a contact with the two cables. The bottom of the box is filled with a solid paraffine and the other with a liquid paraffine oil, which tends to preserve the insulation. The only point where there would be the slightest possibility of leaking would be down at the stuffing-box about the spindle which rises from the brush. This is carefully protected by a specially designed stuffing-box, and experiments have been made by which it is shown that there is no perceptible leakage, and it is claimed that the delicate instruments within, in testing the current, do not indicate any loss whatever. A test was recently made on this road in which the conduit was filled with mud and water to its surface; the car ran into this mixture, stopped and started again, and ran backward and forward, showing that there was an ample current at all times for the movement of the car. The voltage at the time showed about 300 at the starting-point. The road which has thus far been operated has, of course, been merely an ex-



SECTION OF DISTRIBUTING BOX OF THE UNIVERSAL CONDUIT.

perimental affair, but it is intended to make an application of the system very shortly to a road working under ordinary conditions, and give the system a thorough trial through the winter.

ASBESTOS PIPE-COVERING MATERIALS.

In a communication made some time since to the Michigan Engineering Society, Mr. William E. Cooley reported his experience with coverings for steam-pipes. As an instance of the value of steam-pipe coverings, he cited the case of an electric-lighting plant at Ann Arbor, where there was about 60 ft. of 7-in. pipe connecting the boiler with the engines. When this pipe was first put up the steam at the further end from the boiler was tested to determine the amount of water entrained, and the average of nine experiments gave 31.01 per cent. of moisture. A few months later, when the pipes had been covered, the quality of the steam was again tested, and the average of five experiments gave 3.61 per cent. moisture. The tests were made by the same men, from the same connections, and in the same manner. The quality of the steam at the boilers was tested, and gave about 3 per cent. of moisture at the later experiments, showing that only .61 per cent. of moisture was developed by condensation in the pipes at that time. From this he made a calculation assuming that 100 indicated horse power were to be developed, and that each horse power would require 30 lbs. of steam; then if the steam is assumed to have 35 per cent. of entrained water due to condensation, 4,000 lbs. of steam will need to be produced in the boiler, or 1,000 lbs. more than necessary. To produce this would require about 125 lbs. of coal per hour, costing $450 per year, which would pay 6 per cent. interest on $7,500, whereas the cost of the covering did not exceed $150.

ASBESTOS PIPE COVERINGS.

The illustrations accompanying this show the asbestos pipe covering which is manufactured by the H. F. Watson Company, of Erie, Pa. This covering, as shown in the illustration, is what is known as the molded type, but it is also made woven, so that it can be wrapped about the pipe like a felt covering. This molded covering is made of asbestos fiber and other non-conductive materials, which fit pipes of varying diameter from ½ in. upward, and it is shaped to fit elbows, T's, and valves. It is so arranged that it can be applied by inexperienced workmen, and whether the pipes are hot or cold, it will stand all temperatures of heat or cold without cracking or crumbling, and is covered with a canvas jacket which can be removed without injury or waste.

The firm also manufacture the boiler covering or lagging that is of essentially the same formation as the woven covering to which we have already referred, and is furnished with or without a canvas jacket, which can be fastened or applied by using staples, or the sections can be laced together. The advantages of this style of boiler covering is, that when cement or plaster work is removed for repairs to the heated surfaces, it has to be replaced with new materials, whereas this can be laid aside, the work completed, and the same section replaced. The elasticity is another good feature, which allows the covering to be shaped to fit almost any irregular surface. As a covering for locomotive and marine boilers it is especially suitable, and has advantages which recommend it for these uses. It will not crumble or fall away when subjected to the constant jarring of engine work, and will remain as firm and useful as when applied.

In addition to other boiler and pipe coverings, the same firm also manufactures asbestos roofing and also asphaltum covering and tarred felt for the same purposes. Their asbestos manufacture also includes a plastic stove lining, a furnace cement, and asbestos mill board, together with various forms of sheathings and coatings.

COMPARATIVE TEST OF THE WESTINGHOUSE AIR BRAKE COMPANY'S NINE AND ONE-HALF IN. AIR PUMP AND THE NEW YORK AIR BRAKE COMPANY'S NO. 2 DUPLEX AIR PUMP.

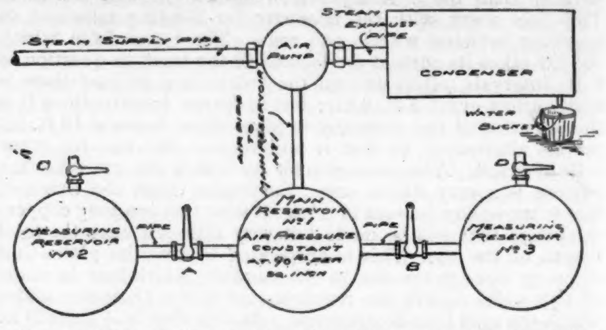
THE following is the average result of a series of comparative tests to ascertain the relative efficiency of the Westinghouse Air Brake Company's 9½-in. simple air pump and the New York Air Brake Company's No. 2 duplex air pump, the latter having two 7-in. steam cylinders and two air cylinders 10 in. and 7 in. respectively in diameter. The test was made by the Westinghouse Air Brake Co.

Name of Pump and Size.	Duty required to raise the pressure from atmospheric pressure to 85 pounds per square inch in one cubic foot of space, pumps working against a constant pressure of 90 pounds per square inch in main reservoir; steam pressure 140 pounds per square inch.		Piston Travel in Feet, per Minute.
	Time per Cubic Foot of Air.	Steam per Cubic Foot of Air.	
The Westinghouse Air-Brake Company's 9½ in. simple air pump (one steam and one air cylinder)..........	8 $\frac{326}{1000}$ seconds.	2 $\frac{722}{1000}$ lbs.	118 ft.
The New York Air Brake Company's "No. 2 duplex" air pump, two steam cylinders 7 in. diameter and two air cylinders 10 in. and 7 in. diameter	10 $\frac{334}{1000}$ seconds.	2 $\frac{722}{1000}$ lbs.	179½ ft.

Temperature of air at air discharge pipe connection, after the pumps had been in operation 56 minutes: Westinghouse 9½ in. pump, 442°; New York No. 2 duplex pump, 515°, when the New York duplex pump had to be stopped on account of the air cylinder heating badly, while the test of the Westinghouse pump was continued through a period of one hour and fifty minutes, at the expiration of which the temperature of the air had risen at the discharge pipe to 470°, which in nowise prevented a prolongation of the test, had such been desired. Both pumps were run at full speed, with throttle wide open.

In these tests the pump was coupled to a main reservoir in which a constant pressure of 90 lbs of air was maintained. Communication was made from this reservoir to another of known capacity by means of an opening of a size adjusted to equal the capacity of the pump, so that the pressure was maintained continuously in the first reservoir at 90 lbs. Air was allowed to flow into the second reservoir until it reached a pressure of 85 lbs., when communication with the first reservoir was cut off and the connection made between the first reservoir and the third, of the same size as the second, while the latter was being emptied. By thus alternately filling and emptying the measuring reservoirs it was possible to maintain a uniform resistance on the pump, and to accurately measure the quantity of air delivered in cubic feet. The consumption of steam required to do this work was determined by connecting the exhaust of the pump with a surface condenser, which condensed all of the steam into water. The weight of water used during the period of the test is an accurate measurement of the steam consumed.

The following diagram shows the arrangement of pumps, reservoirs and condenser used in making these tests, and we believe this is the only exact method of making comparisons; and as the method is so extremely simple, we have no doubt that when understood it will be used when comparative tests of air pumps are being made.



NOTE.—Cocks *A* and *B* are graduated so that when opened alternately to fill either measuring reservoirs No. 2 or 3, as required, 90 pounds air pressure is constantly maintained in reservoir No. 1, and as each of No. 2 or 3 are alternately filled to 85 pounds air pressure, cocks *C* and *D* are opened and the reservoirs emptied. The number of measuring reservoirs filled within a given time to 85 pounds pressure is therefore the measure of work each pump is capable of performing as a product of the relative amount of steam used and condensed into water for convenience of measurement by weight.

The results, as given, are the average of a number of carefully conducted tests made expressly for the purpose of determining the relative capacity and economy of each pump, and show the Westinghouse 9½-in. pump to be 17 per cent. superior in capacity and .023 per cent. in steam consumption to the New York No. 2 duplex air pump, while the rate of piston travel of the duplex was 52 per cent. more than the Westinghouse pump.

The construction of the New York duplex pump is such as to be liable to produce a final temperature of the air under compression and air cylinder that is destructive of packing and lubrication. The Westinghouse Air Brake Company has made exhaustive experiments with duplex air pumps, in which the steam cylinders were compounded as well as the air cylinders, thereby securing the economy due to the expansion of steam in cylinders of different sizes. It was found by experiments carried out, as already described, that the consumption of steam per cubic foot of air was less than two lbs., but that the excessive heating of the air cylinder was the same as with the New York duplex pump; and after a most careful investigation they came to the conclusion that the considerable gain in economy in the use of steam did not compensate for the objectionable use of practically two complete pumps, where a single pump would perform the service with considerably less cost for maintenance.

WORLD'S FAIR ROUTE.

FOUR HUNDRED MILES AS THE CROW FLIES